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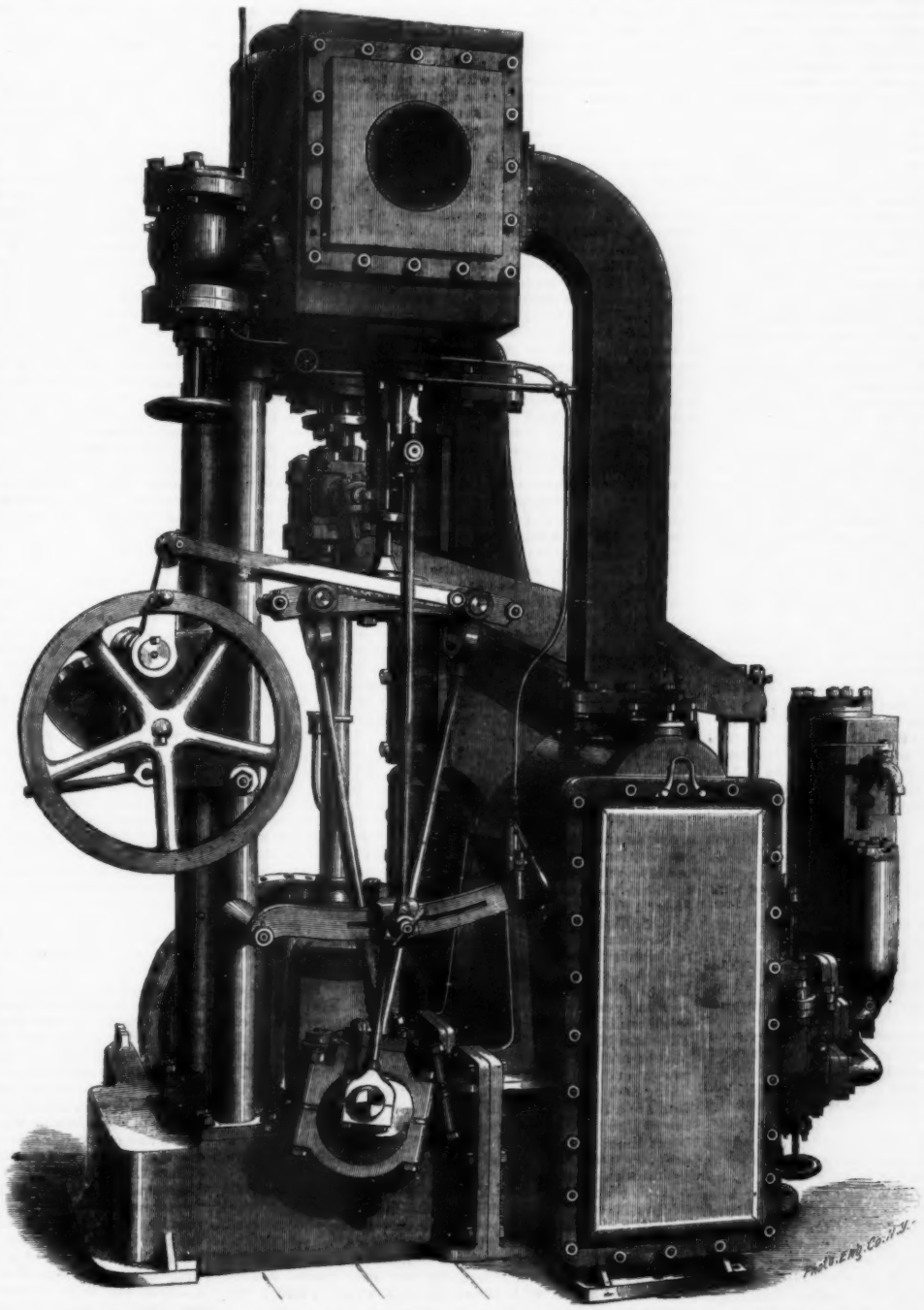
THE INTERNATIONAL EXHIBITION.

MARINE ENGINE, BY CRAMP & SONS.

AMONG the comparatively few exhibits of marine engines at the Centennial, those of Messrs. William Cramp & Sons, of Philadelphia, occupy a prominent place. We illustrate the smallest of their exhibits, a single-cylinder, high-pressure, surface-condensing engine. This class of engine has been largely introduced upon tug-boats running on the Delaware and other rivers, where paddle-wheels are generally abandoned for screws on towing boats. As shown in the engraving, the point of cut-off is controlled by altering the stroke of the expansion valve. It will be seen that the lower end of the expansion-valve spindle terminates in a crosshead, working in guides. On the side of the crosshead is a pin on which is placed a link which descends as far as an oscillating segmental arm attached at one end to one of the main pillars forming the framing of the engine. To this arm, which is graduated, is attached the upper end of link to which motion is given by a crank on the main shaft, as shown. The lower end of the link descending from the crosshead of the expansion-valve spindle, slides upon the graduated arm, and may be locked in any desired position by means of the screw and handle shown; and by sliding it to and fro, any desired degree of expansion may be obtained. The reversing gear consists of a hand-wheel, carrying a pinion on its shaft which gears into a segment with internal teeth, and throws the lever attached to the link to and fro. The air pump is worked in the ordinary way by back levers connected with the crosshead, which latter works on a slipper guide upon the main frame.

The diameter of cylinder of this engine is 20 inches, and the length of stroke 22 inches. With 59 lbs. initial pressure in the cylinder, and a speed of 100 revolutions per minute, an indicated horse-power of 196 was developed on trial.—*Engineering.*



THE INTERNATIONAL EXHIBITION OF 1876.—MARINE ENGINE, BY CRAMP & SONS.

THE INTERNATIONAL EXHIBITION OF 1876.

No. 18.

AMERICAN IRON AND STEEL EXHIBITS IN THE MAIN BUILDING.

THE future of this country—in what may be yet to come of the "iron age"—in the production of the two substances most important of all things to the world's material progress, iron and steel, is strongly foreshadowed in the above exhibits; and, extensive and comprehensive as are those of Sweden and Great Britain in the same building, they are dwarfed by comparison with the extraordinary number and extent of those from the different sections of the United States. Upon an examination of these exhibits, succeeded or preceded by a consideration of the fact that about three fourths of the floor area of that immense building, Machinery Hall, is covered by machinery which came from American establishments, one can not resist the impression that a country possessed of such boundless resources, and capable in the first one hundred years of making such a showing of its ability to utilize them, must soon lead the world in these things.

The Philadelphia and Reading Railroad Coal and Iron Company make a very extensive display, which includes not only the coal and iron, but also all the principal agricultural and mineral productions from the vicinity and on the line of the road. This very much resembles in completeness some of the extensive collective exhibits from abroad, as from some of the British colonies. They show many varieties of limestone, iron ores, and sandstones. One large specimen of magnetic iron ore, with a mass of iron nails clinging to it, is quite an attraction to the curious. The specimens of coal exhibited by this company are, as might be expected, very fine. They show a large number of pieces, coming from five grades of pig-iron, the product of the Ringgold, St. Clair, and East Pennsylvania furnaces; one specimen of bar from these irons has stood the test of 60,000 lbs., tensile, to the square inch. The various stages of the processes incidental to the production of railroad and other bars are illustrated in specimens of the work at those stages, such as piles of bars ready to roll into bars and blooms—the latter ready for the wash heat and the rolling into rails. Then there are a number of specimens of their standard rails of different patterns, some of which have been twisted cold out of all semblance to such a thing, to show the toughness of the material. An old rail of 64 lbs. to the yard, which had been in service over six years, and had withstood the passage over it of 56,000,000 tons of traffic, was twisted cold until the convolutions had a pitch of about 18 inches. The processes also of working up old rails and material are illustrated by specimens in the various stages.

The Rockhill Coal and Iron Company show very fine specimens of coke, coal, iron ore, and pig-irons from their mines and works.

The Shelby Iron Company, of Shelby, Ala., exhibit hot-blast and car-wheel irons, as well as the ores from which they are obtained, in large variety. They show one of the most remarkable specimens ever seen of limonite or hæmatite iron ore, in that peculiar natural formation known among mineralogists as the "geode," which has the form of a huge hollow boulder, with the interior surface of a very distinctly marked mamellar character. It is about 6 feet long and 4 feet high, with walls 6 to 10 inches thick. This ore is largely found in such form; but this particular specimen is a most remarkable one.

The celebrated iron ore deposits from Lake Champlain and the Adirondacks are brought to notice in large pyramidal columns of the ore, with accompanying analysis of them. Witherbees, Sherman & Co., of Port Henry, N. Y., show one column, the ultimate analysis of which is: iron, 70.38; phosphorus, .076; sulphur, none. Port Henry Iron Ore Co.'s column gives: iron, 69.30; phosphorus, .060; sulphur, none. And a second gives: iron, 70.30; phosphorus, .082; sulphur, none. The Lake Champlain Iron Ore Co.'s analysis gives the remarkably fine result: iron, 71.11; phosphorus, .020; and sulphur, none. A deposit called the "new bed," in this vicinity, has still less of that stubbornest and most troublesome of all the constituents of iron, phosphorus, and is now largely used in the production of Bessemer steel.

The Tuscarawas Coal and Iron Co., of Canal Dover, O., show a remarkable specimen of the black-band iron ore from a vein having a thickness of six feet, as well as coal in several fine varieties, and pig-irons from the ore from the furnaces of Rhodes & Co., Cleveland, O. They also show a very fine and large assortment of magnetic, titaniferous, and specular ore, and pig-irons from them.

The Katahdin Iron Works, of Bangor, Me., show a fine assortment of ores and pig-irons.

Singer, Nimick & Co., of Pittsburg, Pa., make a splendid exhibition of cast-steel, rolled by Lauth's patented process. They show refined tool steel in every variety, and saw-plate which, if possessed of the other necessary qualifications in equal degree with the finish of the surface, will be second to none. From the thinnest pen-steel to the six-foot circular-saw plate, it has a surface and polish equal to that of the finest Russia sheet-iron—a feature which, in plates for large saws, must economize in grinding to a considerable extent. They also show a large variety of steel carriage-axles and springs of most excellent workmanship.

From the Hanging Rock iron region of Ohio and Kentucky a large number of firms combine to make a most extensive and interesting exhibit of the coal, ores, and limestones from that region. Among these the Ætna Iron Works, of Ironton, Ohio, make a fine showing of the sesquioxide, or clay ironstone, from their lands in Lawrence County, O.; Traber & Aubrey, of Cincinnati; the Milton Furnace and Coal Co., Wellston, O.; Hiram Campbell & Sons, Ironton, O.; the Empire Iron Works, Trigg County, Ky.; Culbertson, Fashart & Co., Riverton, Ky.; the Raccoon Mining and Manufacturing Co., and Penn Furnace Co., of Riverton, Ky., and the Lexington & Carter Mining Co., of Lexington, Ky., all present very fine samples of ore, coal, hot-blast pig, and cold-blast car-wheel irons, as well as specimens of chilling of car-wheel treads equal to any thing here.

From this section also Robert Scott & Co., of Riverton, Ky., make an excellent display of cold-blast, car-wheel pig, with the ores; the Hunnewell Furnace Co., of the same place, hot-blast pig and splint coal of very fine quality; and the Charlotte Furnace Co. show hot-blast pig in many grades. Altogether this display shows the Hanging Rock Valley to be a most important centre in the iron trade.

The Albany and Rensselaer Iron and Steel Co. make one of the most extensive exhibits in their line in this building. In the front part of their space stand two tall columns, made up of steel rails and round bars highly polished throughout, and around their bases are placed sections of the ingot about five feet long, in every stage of the rolling process, from the crude ingot to the finished rail. They show a steel rail 30 feet long.

highly polished on every particle of its surface, and another of equal length twisted up cold until it resembles a huge rope of steel. Among the many establishments which show railway axles bent into the form of a U, while cold, this concern outdoes them all by showing one not only doubled up in this way, but hammered together at the crown of the bend, until both halves touch each other for a considerable distance, and all without signs of fracture. They also exhibit a large variety of frogs, switches, fish-plates and bolts, sections of different patterns of rail, flanged boiler-plate, angle-iron spikes, etc. They make a very fine exhibit of fractured specimens of iron, which for fibrous texture excels any thing at the exhibition. A curiosity, illustrating the perfection of the work done with their Bessemer steel rivets, is a section through a line of such rivets and four plates held by them, in which the lines marking the junction of plates and rivets are but just discernible.

To show the welding properties of Bessemer steel, a ring of a circular section of about one inch, and eight inches diameter, welded from a round bar, is turned and polished, and the place at which it was joined is undiscoverable. An analysis of this steel gives: Carbon, 0.25; silicon, 0.052; sulphur, 0.065; phosphorus, 0.066; manganese, 1.120. They show specimens of taps, dies, files, and cutlery made from Bessemer steel by H. Paddock's process, and fractured pieces of the same material which show as fine a texture as that of the highest grade of cast-steel. Then there are cut spikes and nails made from the Bessemer metal, which must be valuable in places where the iron nail so often fails. They show, also, Bessemer steel made from the "new bed" Champlain ore mentioned above, which, among all the deposits in that vicinity, contains the least phosphorus, and is, therefore, the best adapted to the production of that steel. They show a certificate of Mr. E. H. Vaughn, Superintendent of the Company's works, to the effect that all the twisted and polished rails shown are from the usual make and stock of the Company.

Hussey, Wells & Co., of Pittsburg, Pa., make a very fine display of their specialty, homogeneous crucible steel, and have in their space a magnificent stand of refined cast-steel bars of every desired form, from a 6-inch octagon to ¼-inch round or square. They show some very fine specimens of flange forging from crucible steel plate. One notable piece from a circular plate, 3 feet 6 inches in diameter, is flanged down at the edge 5 inches deep, and from seven ½-inch holes the same number of flue flanges have been turned to 7½ inches diameter, and 3½ inches high; and another with a 15 inch hole, with flange 6 inches deep in the centre of a sheet, turned down on the edges to the form of a heart-shaped shield. They show a flue sheet or boiler head of 72 inches in diameter, having three flue openings 18 and 30 inches diameter, with flanges 5 inches deep and the edge flanged down 6 inches. The material of which this plate is made stood a tensile test of 76,000 lbs. to the square inch. It is certainly one of the finest pieces of this kind of work ever done. They also show axles bent under drops with repeated reversions, pieces of the plate folded up like lead, four and six thicknesses, and in fact have resorted to every imaginable means of exhibiting the good quality of their products.

The well-known Sligo Iron Mills of Phillips, Nimick & Co., Pittsburg, Pa., make a most comprehensive exhibit of this celebrated iron, and have been quite as painstaking in producing test pieces of marked interest as their neighbor, last mentioned. Among the many noticeable specimens shown are the following: A circular plate of iron ⅝ inch thick, and 106 inches diameter, the material of which has stood the test of 62,000 lbs. to the square inch; some specimens of flange forging which are second to none (actual tests of the iron of the latter have stood from 70,000 to 76,800 lbs. tensile strain to the square inch); many pieces of punched and stretched bars showing remarkable toughness, and a rather curious specimen in shape of a washer, 2 5/16 inches diameter and ½ inch thick, had by punching first with a ¼-inch hole and subsequently stretched and forged out to a ring 10½ inches diameter, having a section of 7/16 x ½ inch, and perfect in every part.

Perhaps one of the most curious and at the same time conclusive test pieces of work among the iron exhibitors—and they seem to have exercised much ingenuity in discovering severe processes to which to subject this metal—is a square plate flanged out in a round opening in the centre from ¼ to 6 inches diameter, and after this had been completed the corners were drawn out in the fire, each into two taper round rods, from ⅝ to 7/16 inches diameter and about 10 inches long: then, after polishing these rods thoroughly, they were tied up cold into a tight double knot, and this was done on all four corners. An actual test of specimens from this plate of iron, as testified to by the inspectors' stamp, was 99,840 lbs.

Another remarkable specimen is that of a piece of iron 9 x 3½ inches section and about 3 feet long, doubled up cold without sign of yielding on the exterior circumference. The whole exhibit is inclosed with a fence made of polished bars, tied into close knots.

The exhibition in this line is so extensive, and so many excellent displays yet remain to mention, that I shall be obliged to devote another letter to them. J. T. H.

THE INTERNATIONAL CARRIAGE EXHIBITION.

ON page 309 of our SUPPLEMENT we gave an engraving of the special building erected for the exhibition of carriages at Philadelphia. We now proceed to give some account of the contents of the building, which are highly interesting and remarkable. We are indebted to the Philadelphia *Ledger* for the following:

This building is situated north of the western end of the Main Building and west of Memorial Hall; is one story in height, and contains 79,350 square feet of floor space. In appearance it is unpretending, but little attempt having been made to secure architectural effect. The sides have been covered with corrugated iron, instead of the ordinary wooden sheathing, and the whole exterior has been colored in drab, picked out with blue. Owing to the fact that a large proportion of the exhibits are carriages and other vehicles, the public has given the structure the name of "Carriage Building." This name is, however, incorrect, from the fact that in addition to vehicles it contains a great number of other exhibits of a very varied character, and consequently the name which is officially employed is simply "Main Building Annex." There is another annex to the Main Building on its southern side, which was erected for an exhibition of minerals, and this is distinguished from the annex previously mentioned by being called "Mineral Annex."

In speaking of the northern annex we shall, however, retain the name "Carriage Building," as it is best known by that name to the public. The floor space is divided by two intersecting avenues into four large sections. Of these the two which lie south of the avenue running east and west are occupied almost exclusively by vehicles of various descriptions and carriage wood work; while the two northern sections are occupied by a great variety of exhibits. Of the latter the north-western portion contains chiefly steam railway cars, street cars, children's carriages, carriage fittings, models of different kinds, ornamental iron work, wire work, and basket work; while the north-eastern section is filled with stoves, ranges, and other heating and cooking apparatus, plumbers' work, refrigerators, and a wide range of house-furnishing goods Owing to the late date at which it was commenced, and the dilatory action of many of the exhibitors, the building was not, until a comparatively recent period, ready for visitors.

The American exhibitors number 430, and the foreign exhibitors 20.

CARRIAGES.

The exhibit of carriages, sleighs, etc., is by far the largest, and, with the exception, perhaps, of the steam railway cars, the most attractive to the average visitors of any of the exhibits. In addition to exhibits from the leading manufacturers of the United States, there are exhibits from well-known makers in England, Russia, Austria, Canada, and Italy.

AMERICAN CARRIAGES.

Beginning with the American exhibitors, we have, as coming first in order on the eastern side of the avenue, *Brewster & Co.*, of Broome street, New-York. This firm makes a very handsome exhibit of both carriages and sleighs. Of the carriages, the first is a glass front landau, with lining of new French cloth, in imitation of pebbled morocco, colored in rich green, dotted over with tufts delicately spotted in crimson. The body of the carriage is of dark green, with a fine line of carmine on black mouldings. The running gear is of black—a new feature in carriage painting—with wheels of carmine striped with black. The carriage bears the arms of Hon. Hamilton Fish, U. S. Secretary of State.

In front of this is a lady's brougham, with lining of rich green satin. In the front portion is a toilet case of bird's-eye maple, with revolving mirrors and rosewood front, silver mounted, and so arranged that it may be pushed in, like a drawer, out of sight. The exterior is colored in black and very dark green, relieved with the coat-of-arms of Charles Francis Adams. Near this is a light square landau colored in rich lake, relieved by black and vermilion lines. On the doors is painted a fancy monogram, with crests in silver. The effect of the silver on the lake is very striking. The carriage has silver mountings, and is lined with maroon-colored morocco, cloth, and lace.

The next carriage is a Victoria—a revival of an old French pattern—with rumble for servant behind. The body and running gears are of rich lake, with lines of vermilion. The trimmings are of maroon-colored morocco and cloth, with plain rep lace, and foot cushions.

The exhibit of buggies by this firm comprises two specimens—a one-man wagon, weight 132 pounds, and a two-man wagon, weight 214 pounds. These wagons are furnished with a new side-bar attachment, which is claimed to be simple, and at the same time to secure great ease in riding. Sleighs are represented by three specimens, two of them being after the style known as the Kimball Brewster sleigh (Portland style), and the other the Canadian sleigh. Of these the first is a light sleigh, weighing only 80 pounds, colored in black, with lines of gold, and trimmed with dark green velvet plush, while the second is a sleigh similarly finished, for two people, with dark maroon trimmings. A new feature in these sleighs is a small wire sieve on the dash to keep out snow-balls and drift-snow. The Canadian sleigh is colored in maroon, relieved with red, and is lined with maroon-colored cloth. There are bearskin rugs, and a new feature is the extension of the runners above the dash for a height of five and a half feet. These are surmounted with horse-hair plumes dyed in solferino. From the ends of the dash hang silver bells.

Near the sleighs is exhibited a gentleman's driving phaeton, commonly known as the Stanhope phaeton. The trimmings are of chocolate-colored cloth, and in the painting of the running gear there is a very tasteful combination of chocolate, black, and orange. In front of this firm's exhibit is an easel, on which are a number of panels, bearing coats-of-arms executed by Peter Barry, heraldic painter for the firm. The colors are laid on a ground-work—in some of the panels of lake, and in others of blue, or chocolate. At the top is the coat-of-arms of the Emperor of Brazil, beneath which are the coats-of-arms of Washington, Jefferson, Hancock, Lafayette, Adams, Hamilton, Franklin, and Warren, surrounding a central panel, which bears the shield of the United States. Near these will be placed two oak figures, carved to represent a coachman and groom. The exhibits of this firm are not in competition, owing to the fact that Mr. C. P. Kimball, a member of the firm, is a member of the Executive Committee of the Centennial Commission, which has the appointment of the Judges.

A. S. Flandrau, of New-York, as agent for *H. Killam & Co.*, of New-Haven, Conn., exhibits two handsome landaus. One of these is colored black, with a fine line of green, and is lined with dark green cloth. The other is similarly finished, having a black body, relieved with delicate green striping, and running gear decorated with lines of gold. Near these is a small family coach, colored in lake and black, striped in carmine and black. It is handsomely finished inside with rich purple leather and cloth. Another coach is colored in rich brown and black, relieved with light brown striping. The lining is of rich brown satin. The remaining exhibits of this firm are a handsome coach painted very dark blue, with striping of lighter blue, and running gear colored in carmine, with black lines, and lining of blue cloth, leather, and silk, and an ordinary coach with plain body and gold mountings, and lined inside with dark green.

A. S. Flandrau, of New-York, as agent for *B. Manville & Co.*, of New-Haven, Conn., exhibits some fine specimens of work in both carriages and wagons. There is, first, a large coach with five windows, and richly finished in green cloth; then a carriage of similar build, colored in maroon, with striping of red, and with maroon trimmings; an open wagon for four persons, trimmed with blue; two top wagons, and a very pretty barouche.

Studebaker Brothers, of South Bend, Indiana, exhibit, in a large plate-glass case, a very light wagon, with a piano-box body, and enamelled leather, painted in black. This wagon is designed to be an exhibit of how considerable strength may be combined with extreme lightness. This firm also sends a road wagon for four persons, with maroon-colored lining, and running gear of light maroon, with blue striping. In addition to this is a wagon for country roads, with the body and running gear left unstained, in order to show workmanship. The body is of sugar maple, the axles of hickory, and the hub of birch. The woodwork is neatly inlaid with black walnut and red cedar. There are also exhibited samples of the Studebaker wheel, with spokes which have their shoulders sloping, enabling them to resist a greater strain than the ordinary square-shouldered spokes.

On the wall near by, the *Hub* Publishing Company exhibit drawings for carriages made for the *Hub* newspaper.

The *Abbott Downing Company*, of Concord, N. H., send a specimen of their ordinary hotel coaches, painted in red, yellow, and black, lined with buff leather, and very substantially made; also a coach for staging, with canvas cover, but otherwise finished much like the hotel coach.

Fulton, Walker & Co., of Philadelphia, exhibit a business wagon, such as is used by merchants, and a substantially built express wagon; and *J. M. Mayer*, Rondout, N. Y., sends three sleighs, decorated in different colors, with very light running gear, and graceful curves.

Hugh Smith, of Gray, Maine, exhibits two unpainted wooden sleighs; and *G. W. Wagner*, of Roxborough, Philadelphia, sends a small sleigh painted in maroon, with stripings of gold.

Charles Behlen, of Cincinnati, sends three vehicles—a light buggy in plain black, with running gear of dark blue, relieved with lines of gold; a coach gear buggy for four, painted black, and relieved with gold mountings; and a child's hearse, elaborately decorated in white and gold, and with festoons of artificial flowers hanging from the roof inside and showing through the plate-glass. Another Cincinnati maker, *J. W. Gosling*, exhibits two carriages—a buggy with side springs, which is claimed to give greater ease of motion than the elliptic spring, while combining the advantages of the side-bar attachment; and a handsome Brett, painted black, relieved with gold mountings, and trimmed in brown.

William P. Sargent & Co., of Boston, make a large and handsome exhibit of carriages in a variety of styles. These include a barouche in black, with running gear of blue, and lining of blue; a light top buggy for two, lined with green; a very pretty sleigh, painted black, with gold finish, and lined with black cloth; a Goddard pattern buggy, painted black, with running gear of black, striped with red, and lined in light drab cloth; an open carryall, with seats for six persons; and a handsome coupé, lined with green silk and cloth, and having a card-holder, and a spring which permits the door to be opened from the inside without the necessity of reaching out.

On the western side of the avenue, the first exhibitor, beginning at the north-west corner, is the firm of *Wm. D. Rodgers & Co.*, of Philadelphia, which makes a very fine display, not only of workmanship but also of taste in decorating. The first of their exhibits is a *vis-à-vis* barouche, which shows new and very pretty lines, with effective coloring in claret, relieved with a fine red stripe, and lined with purple morocco and French chagriné. Next to this is a cabriolet, with body of black relieved with panels of blue and running gear of carmine. The lining is of rich blue cloth and morocco. There is also a full-sized family coach, the bottom panels being in dark green, and the quarter panels in black, relieved with a line of New-York red; the running gear is of dark chrome green with striping of vermilion. The trimming is of dark green chagriné, and of lace colored in brilliant green and red. Next to this is a landaulet for two persons, with seat for child. The front of this carriage will come off, making it adaptable either for a summer or winter carriage. The panels are of rich blue, with striping of lighter blue, and the running gear is of blue, with delicate lines of vermilion. The lining is of blue chagriné, dotted over with tufts of blue, orange, and scarlet. The lace is of blue, with rich figure-work in pink and spots of yellow. In addition to the heavy carriages exhibited by this firm are two light wagons—one a two-man buggy, hung on *Rodgers & Co.'s* patent side-bar spring, and colored in black and green, with the upper portion of the body covered with a fine piece of cane-work, and a light one man top wagon, weighing 123 pounds, and very graceful in its outlines. This is also hung upon side-bar springs.

Charles S. Caffray, of Camden, N. J., makes a specialty of light sulkies and road wagons. Among his exhibits is the sulky in which Goldsmith Maid trotted a mile in 2 minutes 14 seconds at Mystic Park. This sulky weighs 49 pounds. Near by is another of the same general finish, weighing 51 pounds, and painted white with three fine lines of gold, laid on with the greatest delicacy of touch, and making a very handsome finish. A two man Windsor buggy, with shifting top, is the next exhibit. This wagon weighs 210 lbs., and has a body painted in black, with running gear striped in dark blue. The wagons built by this firm are hung on *Caffray's* patent side-bar attachment. Another of the exhibits is a stiff pole road wagon weighing 243 pounds, with body of black and running gear of dark green, striped with two very fine lines of pea green. Next to this is a double-seat Surrey road wagon, colored black, and with running gear in rich carmine. The trimming is an English plaid cassimere. Near by is a drag, with body in black, and hung upon four springs with platform attachment, and trimmed in silver gray cloth. The mountings are of silver, and the running gear is rich maroon, with lines of carmine.

James Goold & Co., of Albany, N.Y., exhibit both carriages and sleighs, the latter particularly being noticeable for great care in finish and taste in decoration. The first of these is a pony sleigh with body in black, relieved with lines of white and carmine, and runners of black and carmine. The next is a sleigh with phaeton body in black with striping of gold, and lined with purple plush, and running gear of red relieved with black. The floor is covered with an exquisite carpet, the groundwork of which is rich green, covered with delicate flowers in crimson and white. Near by is a very large sleigh with landau body, which may be closed up tight in case of disagreeable weather, so that it may be made as warm and comfortable as a coach, while it may be also let down and made to resemble an ordinary sleigh. The body is of black, with lines of red and gold, and trimmed inside with Magenta-colored silk. This firm also exhibits a handsome "drawing-room" coach, very large, with body of black, and running gear of black and carmine. This carriage is so arranged that it may be used as an ordinary coach, or by taking out a section of the sides, may be turned into a partially open carriage. The lining is of brown pebble, grained morocco, and silk. A two-man top buggy, with black body, and running gear of black, with striping of green, is also exhibited.

Wm. Hunt, of Camden, N. J., exhibits two light sulkies for trotting, and *R. M. Stivers*, of New York, exhibits circular combination spring wagons with side-bar attachment. He also sends a very pretty sleigh, with lining of gray wolf-skins, edged with beaver. The body is of very dark maroon, with lines of red, gold, and white. The runners are of red, black, and gold, with traces of white and gold.

J. B. Brewster & Co., of Twenty-fifth street, New-York, exhibit specimens of different styles of carriages very handsomely finished. Among these are two Windsor wagons, one with plain varnished body and running gear, and lining of blue, and the other with the exterior also colored in black, and lined with dark green. Near these is a large coach with black body relieved with lines of carmine, and running gear

of carmine striped with black. The coach is handsomely trimmed in blue. The next exhibit is a landaulet of dark brown, with running gear of alternate stripes of black, brown, and yellow; and adjoining this is a very pretty coupé in black, with green lines, and trimmed inside with rich green cloth and silk. The running gear is of black, with green stripes. The rest of the exhibit of this firm comprises a barouche on C springs, lined with blue, and with running gear in yellow and black; and a landau, with the lower panels of dark maroon, relieved by striping of brilliant carmine, and the running gear of black, maroon, and carmine stripes.

S. S. Scovill & Co., of Coldwater, Mich., send two light trotting sulkies; and *Ford & Co.*, of Tippecanoe, Ohio, exhibit a light unpainted wagon, with wire band wheels.

A full exhibit of carriages is made by *Messrs. McLear & Kendall*, of Wilmington, Del., who send a *vis-à-vis*, or ladies' double phaeton, in maroon, with black border, and running gear of very dark maroon, with maroon lining of turkey leather; a lady's pony phaeton, with carriage platform and canopy, and colored in maroon and black, with Turkey leather lining; an extension-top phaeton, with platform carriage, colored in black, with fine lines of green, and lined with green cloth; and an ordinary open front carriage, with one-half finished, and the other half left unpainted to show workmanship and materials used.

F. C. Gilman, of Montpelier, Vt., sends a small wagon with Concord side-spring, and a light sulky. The body of the wagon is of birch, varnished, and with a panel of curled maple, also varnished; the wood-work is left uncolored.

Wm. H. Wright & Co., of Wilmington, Del., exhibit a jump-seat Rockaway; and *Jones Guthrie*, of the same place, exhibits an unfinished two-man top wagon, with side bar and Brewster cross-springs, and a wagon after the same pattern, finished, together with a light sulky. A very pretty wagon in uncolored woods is exhibited by *John McDermott*, of Washington, D. C. The body is of rosewood, with a narrow stripe of holly inlaid; the supports of the seat are of curled maple, and the running gear is of hickory. Near by is a three-wheeled velocipede, with saddle-seat and sunshade of green silk.

Crosby, Gilzinger & Co., of Rondout, N. Y., send a pretty no-top wagon, with body of black, relieved with narrow line of gold, and with a new style of springs, patented by the firm. They also exhibit a small sulky, with the same kind of springs. From Oxford, Pa., *Messrs. Bailey & Wilson*, of that town, send a very creditable exhibit. There is, first, a neat two-man buggy, painted black, and having side bars. Another of the same style is prettily colored in dark brown, relieved by gold lines, and with brown velvet plush trimmings. The running gear has a rich ground of gold, with stripes of green and carmine. *Haskell Brothers*, of Philadelphia, send a light two-man buggy, and *Cadwalader, Fitzgibbon & Co.*, of Trenton, N. J., exhibit a no-top buggy, in black, with lining of dark brown, very neatly finished, and a top-buggy for two persons. *S. W. Jacobs & Son*, Philadelphia, exhibit a double-seated buggy, somewhat resembling a large phaeton, and two handsome phaetons; one with running gear left uncolored, to show workmanship, and lined with very dark blue, and the other with dark green cloth trimmings, and running gear of plain black.

Wood Brothers, of New York, send eight handsome carriages, varying greatly in style and finish. One of them is a landau, painted black, and striped in carmine, with silver mountings and dark green morocco linings, with green and maroon-colored lace. The window sashes are of rosewood, and the general finish of the carriage is very stylish. Another landau of the same finish, except that it has brown satin and cloth lining, and glass fronts; two-man buggy, with patent cross-spring; an open phaeton, in black, with stripes of blue and white, and lining of blue; and a dog-cart of black, relieved with stripes of blue; a small open buggy, in black, relieved with fine lines of green; and a coupé left unpainted, to show workmanship, are also exhibited. The last of this set of exhibits is a very handsome cabriolet, with black body, relieved with lines of rich carmine, gold mountings, and trimmings of dark green; in front there is an extra seat for children.

Near by are the exhibits of two Boston firms. *Pray Brothers* send a Goddard buggy, the peculiarity about which is a patent steel washer, and which is colored black, with red lines, and has a cane finish on the body; and a pretty trotting sulky, nickel and silver-mounted, and weighing fifty pounds. *James Hall & Son*, of Boston, also send a Goddard wagon, with cane finish on the body, with running gear of blue, striped with orange. This firm also sends a two-man buggy and a Portland sleigh. The buggy is in black, with dark green lining, and the sleigh is artistically colored in black, with fine lines of gold, with the running gear in effective contrasts of carmine, black and gold. The front of the dasher is of rich claret, and the lining is of Magenta-colored plush. The lines of the sleigh are very graceful and pretty.

James Cunningham & Son, of Rochester, N. Y., send a very full line of carriages. Among these is a landau in black, with gilt mountings, and two narrow lines of green on the running gear. The lining is of rich green satin. Near this is an elaborately-finished hearse in ebony, with rich gold mountings, and with the border about the windows inlaid with gold and silver plate. On either side, near the top, are crestings of doves in silver. At the top is a handsome railing in gold and silver plate, divided into sections, and from which rise urns in gold plate, elaborately decorated. On the top, in silver, is the figure of Faith supporting herself on a cross. The floor is covered with mahogany, silver-mounted, and on either side of it is a railing with vases holding artificial flowers. Next to this exhibit is a landau in black, with running gear of brown; and another in rich maroon, with running gear striped in red and black on maroon. There are also two buggies, one with top and the other without, neatly finished in plain coloring.

Hatfield & Jackson, of Rahway, N. J., send a handsome buggy, light and colored black, with a coat of arms in blue, showing very effectively on the black ground. The running gear is of blue, with lines of gold, and the trimmings are of dark blue. This firm also exhibits two trotting sulkies, and a two-man top buggy, with lining and running gear of dark green.

Thomas Jones & Co., of Newark, N. J., exhibit two sulkies, one very light, weighing only 46½ pounds, and the other weighing 58¼ pounds.

S. C. Rogers, of Philadelphia, exhibits two light wagons very neatly put together, and colored in dark tints.

Renick, Curtis & Co., Greencastle, Ind., exhibit two buggies, with their patent jump seat. One of them has seats for four persons. The body is of black, with a panel of maroon, and is further relieved by fine striping of green. The running gear is of black, relieved with lines of green and orange-brown. The other carriage has seats for two persons, and an extra seat for children. The body and running gear are of black, with lines of blue and orange. Each of the carriages has a coat-of-arms neatly painted on the side panels.

The *Dexter Spring Company*, of Halton, Pa., exhibit two no-top buggies, and the unfinished body of a buggy, to illustrate the workings of their patent springs.

J. A. Bils, of Pleasanton, California, and *M. P. Holmes*, of San Francisco, exhibit buggies; while the *California Carriage Manufacturing Company*, of Sacramento, send a lady's phaeton and a light driving wagon.

A light sulky is exhibited by *L. S. Scranton*, of Grand Rapids, Mich., and an ordinary top buggy and a pretty extension phaeton, are sent by Jacob Rech, of Philadelphia. Extension phaetons are also exhibited by *J. V. Randall*, of Newtown, Pa. *Charles Grube*, of New-York, sends a buggy wagon for four persons and a buggy for two, both handsomely finished.

William Youle, of Norwalk, Conn., sends two hearses richly decorated in ebony and gold and very similar in finish, except that one has vases rising from the inside railing, filled with flowers. *A. McLear*, of West Chester, Pa., exhibits a light family carriage and a buggy, and *D. M. Lane & Son*, of Philadelphia, send a buggy, an extension phaeton and barouche. The buggy is plain black, with blue lining and with running gear relieved by two fine lines of green; the barouche is painted black, with rich green satin lining; and the phaeton is also in black, with the running gear striped with blue. *J. Beckhaus*, of Philadelphia, exhibits four handsome carriages; one of these is a three-quarter size landaulet, with plain black body and running gear of maroon, with black stripe; the trimmings are of a brownish purple silk. Near this is an eight-spring coach, with similar exterior coloring and lining of crimson satin. The lace trimming is of crimson and black. A phaeton in black, with running gear striped in green and lining of brown leather, is also exhibited.

J. Collyer, of Newark, N. J., makes a large and very attractive exhibit, embracing two square-bodied coaches, one lined in blue and the other in green cloth, with plain exteriors, and with running gear striped with green; two buggies, an unpainted sulky and a handsome sleigh with coach body hung upon stout runners. The coach is lined with purple silk, and purple and black lace, and the colors employed in painting both body and runners are maroon and carmine.

J. T. Smith & Co., of Boston, exhibit two Goddard buggies. One of them is in black, with a piece of cane-work on either side and colored in black, with striping of gold and red. The other is of the same general build, but is colored in black with green striping. The lining of one is white brocade, with rich drab lace, and of the other dark green cloth. *J. Enders & Co.*, of Louisville, Ky., exhibit a light buggy, with Concord springs. *George K. Childs*, of Philadelphia, exhibits a similar buggy, with side bar. *John Green*, of Wilmington, sends specimens of the ordinary Rockaway carriages, and the *Dexter Spring Company*, of Halton, Pa., send a buggy.

Sargent & Ham, of Boston, send a double-seated buggy, with top, painted in black and gold.

Petry, Geissel, Bayha & Co. and *S. R. Phillips*, of Philadelphia, make a joint exhibit; the former of a carriage, and the latter of a set of harness. The carriage is colored in plain black, with the running gear relieved by green striping. The lining is of rich green silk, with tufts of scarlet, and the finish throughout, although simple, is very striking. Attached to the carriage are four horses, carved out of wood, and painted gray. So cleverly has the work been executed, that at a little distance it is almost impossible to realize that they are not preserved specimens of real horses. They wear a rich and strikingly handsome set of harness, lavishly decorated with gold and silver mountings; and occupying, as they do, a prominent position near the southwest entrance, are the objects of much curiosity and interest on the part of visitors.

The *Carriage Monthly*, of Philadelphia, exhibits woodcuts of carriages, copies of publications, etc. *Rogers, Dick & Lewis*, of Fort Wayne, Ind., exhibit Miller's surfacing fluid, to be applied to the bare wood of carriages and car bodies. *F. T. Clymer*, of Wilmington, Del., exhibits unpainted carriages and hearse bodies. *Charles Palm & Co.*, of Nuremburg, Germany, New-York, and Cincinnati, exhibit specimens of heraldic painting on panels, glass, etc.

(To be continued.)

CAR-SPRINGS AT THE INTERNATIONAL EXHIBITION.

THE exhibitors of American car wheels are all clustered together on the north side and near the west end of Machinery Hall. Scattered around them are the car and locomotive springs. These are of almost every conceivable pattern, and steel seems to be twisted into all kinds of shapes in order to give the greatest amount of flexibility and elasticity. It will surprise most railroad men who are not experts to find how much there is to learn about the design and manufacture of springs. To those who have never studied the subject, a spring will appear to be a more or less crooked combination of steel plates or bars, intended to form a flexible and elastic support for a car, engine or other vehicle. The practice heretofore, and, it may safely be said, still, is, at many places, to entrust the manufacture of these articles to an experienced blacksmith, who has more or less skill, and who looks wise and mysterious as he draws hieroglyphics on the dirt floor of his shop, or as he plunges the heated plates into a vessel of inscrutable liquid to give them the requisite temper. The proportions of the springs were, and still are, made by such men "by the eye," and sometimes, it must be confessed, they were very good; but a recollection of some of the enormous piles of steel plates which were sometimes used under locomotives produces the conviction that often the proportions, the temper, or the material of the springs must have been wretchedly adapted to the purposes that the spring was intended to fulfil. The truth is that springs, like nearly every other article employed on railroads, have been subjected to more or less scientific analysis. At the same time, spring manufacturers and master-mechanics have been experimenting on the action of springs, so that a workman must now have some better reason for the form and proportions which he gives to springs than one which he has evolved by some process of inscrutable "inwardness."

A number of the exhibitors have also machines for testing springs, by subjecting them to pressure, and thus compressing them to the extent of their elasticity. This "shows" the action of the springs when loaded and compressed. Another method of testing springs which is employed in Europe, has not, so far as is known, been used here. That is, to place the spring under a slotting-machine and make the stroke of the head equal to the action of the spring and then start the machine with a revolution counter attached, so that the number of times which the spring is compressed will be accurately recorded. Doubtless simply compressing a spring by a screw or hydraulic press shows the form which it assumes when loaded, but it gives no idea f its endurance under continued action. However, this is not intended to be a treatise on springs, but a description of those exhibited.

NICHOLS, PICKERING & CO.

This Philadelphia firm has a space 12 ft. square, on which they have erected a platform which is neatly carpeted, and on which they have arranged their springs in a very tasteful manner. The railing around their exhibit consists of columns made of volute and spiral springs, which is a very happy conceit. On top of the railing and on each side of the enclosure are arranged a set of locomotive springs and equalizing levers, and at the back several different kinds of car springs.

This firm exhibits specimens of elliptics 23 in. long x 3½, made of 3½ x 5-16 in. plates. These are for freight or coal cars; also pairs of elliptics 30 in. long x 5½ of 3 x 5-16 plates; 33 in. long x 5½ of 3 x 11-32 in. plates, and triplet springs, that is, three springs attached together side by side, 36 in. long x 8½ in. of 3 x 11-32 in. plates, the latter for passenger cars. They have also a specimen of Mr. Ashbel Welch's compound spring for six-wheeled passenger-car trucks. These consist of one full elliptic on top of a half elliptic. These are placed on the outside of the wheels, and rest on the swing-bearers which project outside. An engraving of a truck with these springs is published in the *Railroad Gazette* of Sept. 30th, 1871, page 295.

The locomotive driving springs already referred to are 38 in. long and made of 3½ x ⅝ in. plates. The exhibit also contains tender springs 48 in. long of 4 x ½ in. plates; one such spring 39 in. long; one locomotive spring 40 in. long, of 3 x ½ in. steel; one 20 in. spring for coal cars, volute springs from 2½ in. diameter x 2½ high, up to 6 in. diameter and 9 in. high. The smaller sizes of the latter springs are used on wood-working machinery. The firm also exhibit nest spiral springs made of flat bars of steel: these very in size from 4 in. diameter x 5½ high, with three coils up to 8 x 8 in. The larger springs have four coils and are used for equalizing bars of passenger cars, and also for bearing springs for freight cars. What are called special draw springs are made of round steel in nests of two coils, and are from 4½ in. diameter x 5½ in. high to 6 in. diameter and 9½ high. Similar springs are made of flat bars 1½ x ⅝ in. rolled edgewise and made of a concave form somewhat like a mark of parenthesis,). Similar springs are also shown made of round-edged steel.

The exhibitors also show specimens of freight-car springs, consisting of groups of six springs made of ⅝ in. round steel in coils 3 in. diameter, and enclosed in cast-iron cases. They also exhibit the Thomas cast-steel reversible nut lock washers, of various sizes. These were illustrated in the *Railroad Gazette* of April 17th, 1875 (page 153). The chief objection to this portion of their exhibit is that most of the washers are nickel-plated, and are therefore not the same article which they supply to purchasers. It would be much more effective if the nickel-plated articles were replaced with others "selected from stock."

A very neat screw punch for notching steel rails completes the list of articles which this firm have sent. It is made of cast steel, weighs only 65 lbs., and will punch a notch ½ x ⅝ in. through plates or flanges ⅝ thick.

J. JEFFRIES' SONS,

of Philadelphia, are represented by an assortment of elliptic and semi-elliptic springs, some of the latter being single, others in couples and triplets. The former are for locomotives and tenders, the latter for passenger cars. They have also examples of spiral nest springs. There is very little that can be said of this exhibit, further than to enumerate the articles which the exhibitors have been wise enough to select from their stock, making no attempt at display. Some of these, true to the traditions of Philadelphia, are painted a dark buff or drab, and are commendably free from all chromo iniquity. The exhibit is, however, deficient in not being provided with any means of communicating information to visitors, and the services of a dusting brush would not be misapplied if it were to hover about the objects displayed.

THE COLUMBIA CAR-SPRING COMPANY,

of New-York, exhibits what are called rubber-packed spiral springs. These consist of a hollow rubber cylinder with a steel coiled spring outside and another inside the rubber cylinder. One pattern consists of a rubber cylinder 4 in. diameter on the outside, 2½ diameter inside and 7 in. high, with a spiral spring of flat steel on the outside and another coil on the inside of the rubber. Another has a single coil 3½ in. diameter x 7 in. high, made of round steel with rubber inside of the coil, and there is also a pattern with a coil of round steel 11-16 in. diameter on the outside of the rubber cylinder, and another coil of ½ in. steel on the inside; the rubber being 4½ in. diameter on the outside, and 3 in. diameter inside, the spring being 6 in. high and held between two cast-iron caps.

There are also nest springs made of round steel and of the following sizes: 5½ diameter x 6½ in. high with three coils; 7 in. diameter x 9 in. high with two coils; also similar springs made of half-round steel in three coils 5½ in. diameter x 6 in. high, and 3 in. diameter x 5 in. high; and others made of flat bars with round edges, one 5½ in. diameter x 6 in. high with three coils, and another of five coils 8 in. diameter x 8 in. high. Besides these there are group springs of six coils each 3 in. diameter x 5½ in. high with cast-iron cap and base.

The springs are all exhibited on a table 30 in. square, and most of them have apparently been draw-filed before being tempered. They present a very neat appearance, but unless the company is in the habit of finishing all its springs in that way, those on exhibition do not fairly represent the articles they manufacture and supply to the trade. This company, we believe, manufactures some of its springs from chrome steel, but whether any of those on exhibition are made of that material we are unable to say. It is but justice to add that from sources which are regarded as trustworthy it has been learned that springs manufactured by this firm have shown an extraordinary endurance when subjected to severe tests. Whether they were made of chrome steel, can not now be stated with certainty.

THE CULMER SPRING COMPANY, OF PITTSBURG.

It is surprising to observe in what a variety of styles such very ordinary looking objects as car springs may be exhibited. The Culmer Company manufactures only, or perhaps it should be said, chiefly, coiled springs made of round steel. These are exhibited in a glass case, placed on shelves rising above each other like successive steps. These are covered with some dark material, and the springs are most of them nickel-plated, so that the effect is somewhat like that of the silver-ware exhibited in the Main Building. The arrangement is very good; the springs are good, as we know from sources of information quite independent of those who make and sell them; but why did not the Culmer Company withhold the

nickel-plating? Its exhibit would have been so much better without it and would have cost so much less than it did.

This company manufactures spiral springs made from the finest steel wire, up to those made of steel bars one inch in diameter. It has spiral springs in use in this country and also in Europe, in steam-gauges, valves, and other delicate instruments where a very fine quality and uniformity of tension are required, and now has orders for spirals 8 in. diameter made of one-inch steel, which require a bar of steel over 100 feet long to make one spring, and has fifty spiral springs in operation on Westinghouse's model of his atmospheric and vacuum brakes. It has about fifty specimens of coiled springs, chiefly car springs, on exhibition, of different sizes and shapes, all, with a very few exceptions, made of round steel. They are made of every variety of shape and size, arranged singly, in pairs, and groups of three, four, five, six, seven, and eight, and also in nests of two and three coils. As already indicated, they are made for a great variety of purposes besides use under cars. It was stated by the agent of this company, that the springs on exhibition, although nickel and gold-plated, are entered for competition, and will be subjected to any desired test. Doubtless they are just as good springs, notwithstanding their ornamentation. A man's beard, if dyed, doubtless serves its purpose just as well as if it were not, but then a person with a purple mustache does not inspire the confidence which he would if that appendage were left *au naturel*.

With its exhibit the Culmer Company has a supply of its excellent descriptive pamphlet. This gives a tolerably full description of the articles exhibited, and the method of their manufacture. The company's agent is also in attendance part of the time, so that abundant means of furnishing information are supplied.

MESSRS. A. FRENCH & CO., OF PITTSBURG.

This firm has the largest manufactory of railroad springs in the country. Their exhibit, however, is modest in proportion to the size of their works. They have a space about 12 x 24 ft., in which they have examples of their springs neatly painted in lead color, with the exception of one set which are highly polished and enclosed in a glass case. Alongside the platform on which the springs are shown is a hydraulic press for testing the springs. This consists of a ram which works upward from the floor with a table on top on which the spring is to be tested or placed. On top of the machine is a long and very powerful lever, the bearing points of which rest on knife-edges, like the beams of a scale. This lever is weighted with any desired load at the outer end, the load resting on a suitable support until the pressure of the ram under the spring is sufficiently great to raise the lever and its load from the support. The pump for working the ram is operated by steam-power. Alongside the testing machine is a small hydraulic lift for handling the springs to and from the testing machine. The platform on which the springs are displayed is neatly carpeted, and provided with a desk and chairs.

The springs exhibited are all either elliptic or of semi-elliptic patterns, and of the following sizes: one pair of the Pittsburg, Fort Wayne & Chicago Railway standard freight-car springs, 20 in. long with five plates of 3½ x 11-32 in. steel; one pair of the Chicago & Alton Railroad standard freight-car springs, 22 in. long with six plates of 3 x 11-32 in. steel; one triplet of the Philadelphia & Reading Railroad standard passenger-car springs, 30 in. long and of five plates of 3 x 11-32 in. steel; one triplet of the Central of New-Jersey standard passenger-car springs, 36 in. long, with 5 plates of 3 x 11-32 in. steel; one triplet of the Pennsylvania Railroad standard passenger-car spring of same size, but with six plates; one triplet, same size, but ⅜ in. plates; one triplet, 40 in. long, with six plates of 3 x 11-32 in. steel; one quadruplet of Pullman's four-wheeled truck palace-car standard, 36 in. long, with five plates of 3 x 11-32 in. steel. Sixty sets of the latter are now in use under Pullman's cars in England. Besides the above, they exhibit one half-elliptic freight-car spring, 30 in. long with six plates of 3½ x 11-32 in. steel, with capacity for a load of 5000 lbs.; one half elliptic-freight-car spring, 32 in. long, with six plates of 3½ x 11-32 in. steel, capacity 5000 lbs.; two 34 in. locomotive springs, with ten plates of 3 x 11-32 in. steel, capacity 9000 lbs.; two 34 in. locomotive springs, with thirteen plates of 4 x 11-32 in. steel, capacity, 13,000 lbs.; two tender springs, 48 in. long with eighteen plates of 3½ x 11-32 in. steel, capacity, 12,000 lbs. There is also another quadruplet elliptic of the New-York Central Railroad standard, 35 in. long and of four plates of 3 x ½ in. steel.

In the manufacture of springs, Messrs. Wells, French & Co. have endeavored to so proportion the different parts as to give the spring an equal amount of flexibility through its whole length when loaded. If one part of a spring has less stiffness or strength than another, it will, of course, bend most at the weakest place, and instead of distributing the flexure over its whole length there will be a tendency to concentrate it at one place, and consequently the spring is liable to break at that place. The duty which a spring has to perform is that of *bending* under a load. If this bending occurs at one place only, or if one place bends more than the rest because there is less material at that place than elsewhere, then it is plain that the spring would be strengthened, or would endure longer, if a part of the material were removed from the stronger places, so as to make it of uniform flexibility all through. Now this is what Messrs. French & Co. have aimed to do, that is, to make a spring of uniform strength all through its length, so that the total amount of bending will be distributed equally through all the steel in the spring. By this means they have accomplished what seems paradoxical—made springs stronger by making them lighter.

Some of those exhibited were subjected to tests under the writer's observation, and showed that while being compressed until the bands touched each other, the amount of flexure was the same all through their length.

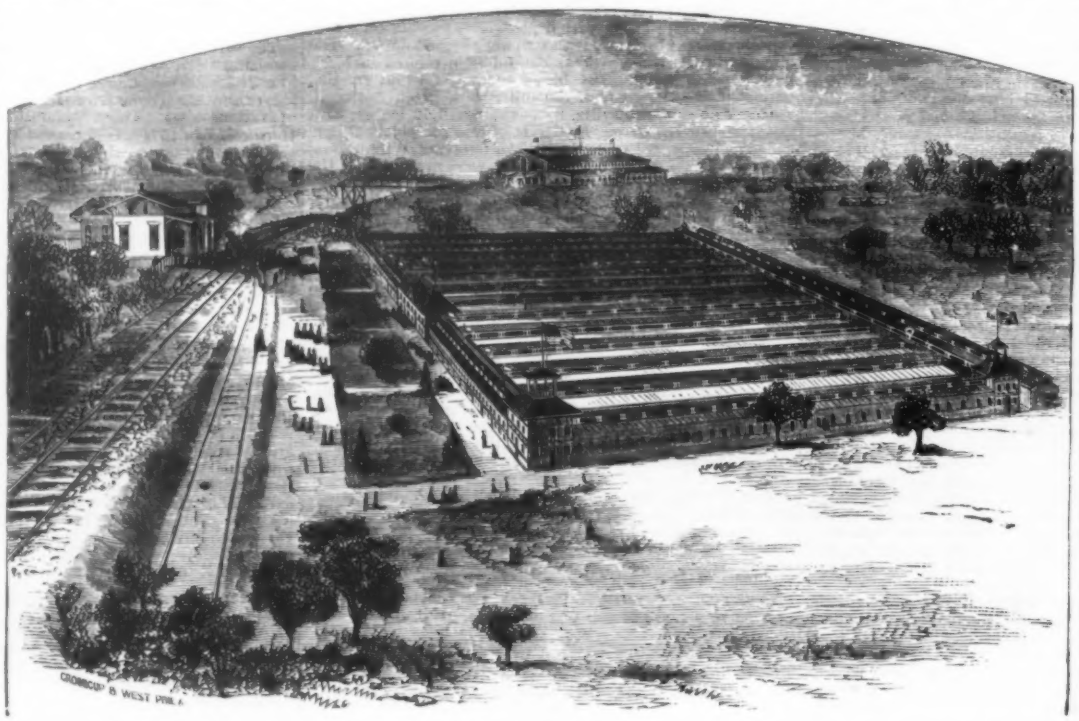
N. & A. MIDDLETON & CO., OF PHILADELPHIA.

It might be remarked of this exhibit, as of some others, that it is remarkable how great a variety of arrangement is possible in exhibiting springs. This firm have a pyramid or rather cone of successive shelves, on which they have arranged the articles which they manufacture. These consist chiefly of small coiled springs arranged in groups in cast-iron cases. The coils are from one to two inches in diameter, and are made of from ¼ to ½ in. steel wire. They also exhibit what is called the Godley spring, which is a coiled spring made of steel, the section of which has somewhat the form of a letter ⊣ laid on its side. That is, the inner edge is rolled thicker than the outer one. Alongside of the stand is what car-builders would call a truck side, with a set of the Middleton springs arranged over an equalizing lever. There is also a pair of jaws and boxes, with a pair of the springs arranged over the boxes.

Across the aisle from the stand is a spring-testing machine also exhibited by this firm. It is operated by a screw from below, which is worked by a long lever with a pawl and ratchet. The springs are loaded on top by a lever.—*Railroad Gazette.*

A GIGANTIC CENTENNIAL HOTEL.

AMONG the temporary structures erected for the accommodation of visitors to the International Exhibition, the Sumner Hotel of the Grangers, or Patrons of Husbandry, is worthy of mention. We give an engraving of the establishment.



THE INTERNATIONAL EXHIBITION.—HOTEL OF THE PATRONS OF HUSBANDRY.

CENTENNIAL ENCAMPMENT OF THE PATRONS OF HUSBANDRY, AT ELM STATION (on the main line of the Pennsylvania Railroad, less than three miles west of the Exhibition Buildings).

OFFICERS OF THE ASSOCIATION.

President, Dr. M. Steck, Grange No. 27, Pa.; Vice-President, William H. Dallett, Grange No. 60, Pa.; Treasurer, Townsend Walter, Grange No. 60, Pa.; Secretary, R. H. Thomas, Secretary Pennsylvania State Grange.

BOARD OF MANAGERS.

W. T. Painter, Grange No. 60, Pa.; Wm. Dean, Delaware State Grange; Mortimer Whitehead, Master N. J. State Grange; Victor E. Piollet, Lecturer Pennsylvania State Grange; Isaac Frazer, Grange No. 16, Pa.; Jas. M. Phillips, Grange No. 198, Pa.; J. C. Amerman, Grange No. 57, Pa.; Michael Schall, Grange No. 103, Pa.

It is alleged to be the largest Summer Hotel building in the world, containing over 1200 rooms, and capable of comfortably entertaining from 3000 to 4000 persons daily. This project was specially designed for the accommodation of members of the order of Patrons of Husbandry, Agricultural Societies, Farmers' Clubs, Sovereigns of Industry, Temperance Organizations, and kindred societies, with their friends, who purpose visiting the great Centennial Exhibition at Philadelphia, individually or in bodies. The buildings (see engraving) are 496 feet in length by 450 feet in depth, situated on a good elevation at Elm Station, on the Pennsylvania Railroad, ten minutes' ride from the entrance of the Exposition Grounds, affording a healthy location, pleasant promenades, romantic and picturesque scenery.

The rooms are each furnished with a new double bed (mattress and springs), chairs, table, wash-stand, ewer and basin, and a mirror; the walls are neatly papered, and the doors provided with a lock and key. The building is lighted with gas, and well ventilated, and the rooms, with the exception of 100, are located on the first floor, conveniently connected with the offices, dining-rooms, wash-rooms, closets, etc. Rooms *en suite* to any number for families and parties, and apartments for ladies unaccompanied by gentlemen.

The reception, promenade, and sitting-rooms are large, pleasant, and convenient.

The dining-room is 330 feet in length and 80 feet in width, capable of seating 1000 guests at a time, without crowding.

On the grounds are located offices of the Western Union Telegraph Company, Adams Express, Pennsylvania Railroad baggage and ticket offices, U. S. post-office, and every convenience and facility for the transaction of business or the sending of news.

A commodious hall is provided, in which Grange and society meetings, lectures, and entertainments are held frequently, with religious services on Sabbaths. Lawful business of every description will be conducted on the grounds. No intoxicating liquors sold on the premises.

Trains of the Pennsylvania Railroad leave and arrive at the grounds every half hour, carrying passengers to the new Pennsylvania Railroad Depot, at the entrance of the Exhibition, in ten minutes.

While this association has been organized for the benefit of the Patrons of Husbandry throughout the United States and Canada, and the entire Board of Managers are members of the order, it is not intended to exclude persons from the Encampment who are not members of the order. On the contrary, entertainment will be open to Sovereigns of Industry, Agricultural Societies, Temperance Organizations, Masonic, Odd Fellows, and Mechanics' Lodges, etc., and to all respectable persons.

The prices are quite moderate—one dollar per day for rooms; meals, fifty cents each.

The Encampment is less than three miles from the Centennial buildings, and on a direct line of railroad. Guests step into the cars at the Encampment, and in ten minutes are landed at the entrance of the Centennial buildings; no delay; no long walk. The return trip is made in the same time.

Persons from the west, north-west, and south-west visiting the Exhibition *via* the Pennsylvania Railroad by way of Harrisburg and Lancaster, and desiring entertainment at the Encampment, should inform the conductor of the train on which they travel, so that the train may be stopped at Elm Station, on the Encampment grounds. Those arriving in the city by any of the steamboat lines, or railroads other than the Pennsylvania, will proceed by street passenger-railway from the depot at which they disembark to the Pennsylvania Railway Depot, Thirty-second and Market streets, and there take trains for Elm station (Patrons' Encampment)—a distance of about six miles. The Pennsylvania Railroad has a baggage office in the building, and will check baggage from all points on their line to the Encampment. The guests will therefore be relieved of all care and expense of handling their trunks when arriving or departing from the Encampment. The following is the time-table of regular accommodation-trains between the Encampment (Elm Station), the Exhibition grounds, and West Philadelphia:

GOING.—Leave Elm Station at 7.10, 7.42, 8.10, 8.40, 9.10, 9.40, and 10.40 A.M.; and at 12.09, 1.40, 3.40, 4.40, 5.40, 6.40, 7.19, 8.10, 8.40, 9.40, and 10.45 P.M.

Arrive at Centennial Depot at 7.20, 7.51, 8.20, 8.50, 9.20, 9.50, and 10.50 A.M.; and at 12.20, 1.50, 3.50, 4.50, 5.50, 6.50, 7.26, 8.20, 8.50, 9.50, and 10.51 A.M.

Arrive at West Philadelphia at 7.30, 8.00, 8.30, 9.00, 9.30, 10.00, and 11.00 A.M.; and at 12.30, 2.00, 4.00, 5.00, 6.00, 7.00, 7.35, 8.30, 9.00, 10.00, and 11.00 P.M.

RETURNING.—Leave West Philadelphia at 6.20, 8.00, 8.30, 9.00, 10.00, and 11.00 A.M.; and at 1.10, 2.30, 3.00, 4.00, 4.30, 5.30, 6.00, 6.30, 7.00, 8.30, 10.30, and 11.30 P.M.

Leave Centennial Depot at 6.29, 8.09, 8.39, 9.07, 10.08, and 11.08 A.M.; at 1.18, 2.41, 3.08, 4.10, 4.40, 5.39, 6.08, 6.38, 7.08, 8.38, 10.38, and 11.38 P.M.

Arrive at Elm Station at 6.40, 8.21, 8.50, 9.17, 10.20, and 11.20 A.M.; and at 1.30, 2.52, 3.20, 4.22, 4.50, 5.51, 6.20, 6.50, 7.20, 8.50, 10.50, and 11.49 P.M.

This does not include the through trains east and west—all of which stop at the Encampment when there are passengers for the Encampment, or going from thence to their homes in the west or north—as follows: Westward—Limited Mail to stop on flag for passengers west of Pittsburg and north of Williamsport; Cincinnati and Pacific Express trains to stop on flag for passengers west of Pittsburg; Fast Line, Harrisburg Express, and Pittsburg Express to stop on flag. Eastward—All through trains from Pittsburg, Harrisburg, and York to stop at Elm and let off passengers who wish to stop at the Encampment.

In addition to the above trains, extra trains will be run when the Encampment is full, that will take passengers to and from the Encampment every thirty minutes, at a fare of fifteen cents to the Exhibition Depot and return.

Letters containing subscriptions to stock, engagement of rooms, or asking further information, will be promptly attended to and acknowledged, if addressed to R. H. Thomas, the secretary, or to the Board of Managers, Patrons' Centennial Encampment, Elm Station, Montgomery Co., Pa.

PROF. R. W. RAYMOND has prepared a table showing the production of leading metals, etc., during the first century of the Republic; we quote:

Coal, Anth., tons of 2240 lbs.				341,521,423
Pig Iron,	"	"	"	40,000,000
Lead,	"	"	"	855,000
Copper,	"	"	"	200,000
Quicksilver, in flks. of 76½ lbs.				840,000
Petroleum, bbls. of 42 gals.				76,594,600

CENTENNIAL EXHIBITION—UNITED STATES DEPARTMENT.

LIGHTHOUSES.

THE display of the Lighthouse Board, under the immediate charge of Lieut.-Col. William F. Raynolds, U.S.A., in the Department of Construction, and Commander G. B. White, U.S.N., Inspector, assisted by Lieutenant Paul, U.S.N., Assistant Inspector, contains much that is of interest.

The first object to strike the eye is the complete lantern and clock-work of a Fresnel light of the first order—that is, largest class. The lantern itself is large enough for a man to walk around in; and standing upon a metal column some eight feet high, turning slowly around, with its curious-looking glasses, and clock-work below, attracts a great deal of attention, although few seem to recognize its purpose. When told that it is a lighthouse, the interest appears to increase; for it is well understood that lighthouses are the guide-posts of the mariner, and also that he is enabled to recognize any particular lighthouse by the color or duration of its flash. The time of the flashes is governed by the clock-work, which causes the lantern to revolve in a certain number of seconds, showing, during a part of the revolution, a clear light, and the rest of the time a colored, or shaded, light, as the case may be.

But the United States Government has a large number of lighthouses: it costs a great deal of money to build them, and still more to supply them with attendants and oil; and, while there is no income direct to the Government from a lighthouse, and the amount of oil it consumes is great, to make that oil do all of the work that it can—that is, to make the light as brilliant and far-reaching as possible, and to prevent waste—has been a matter of study with maritime nations for years. The first point arrived at in this study is that, while the flame of a lamp throws its light nearly equally in every direction, up and down, and all around, the mariner, whom it is designed to benefit, is never much above or below a certain level, and very often he is also confined to a small portion of the circumference, or to one side. Hence it follows that if all of the light thrown by the lamp above or below him can be confined to his level and thrown directly toward him, a smaller quantity of oil will do the work than if a part of the light is wasted upon the stars or the floor of the lantern. This led to the employment of reflectors to direct the light in a level or nearly level plane, which is called the focal plane of the light. These reflectors were generally made of metal, highly polished; and such are still used in some lights.

Glass lenses are also used to concentrate the light in a particular direction. But the value of a glass lens lies in the fact that its surfaces are not parallel; for as the refraction or bending of the rays of light will only take place upon their passage from one medium, as the air, to another of different density, as the glass, and *vice versa*, so, also, that refraction takes place only at the actual surface of contact; and a thin piece of glass will cause just as much refraction as a thick one if the angles are the same. With parallel surfaces the same refraction takes place as in any other case; but the refraction, on passing from the glass to the air, or from the air to the glass, being just equal, only in contrary directions, they just compensate for one another, and the rays pass on in a direction parallel to that they had before entering the glass, whatever the angle to their course at which the glass is set. But as the angle of refraction really varies with the angle at which the ray strikes the refracting surface, so, by making the surfaces of the glass inclined to each other, the refractions do not balance, and the rays may be made to take a direction, on leaving the glass, that is totally different from that at which they entered it. Taking advantage of this, the rays that would go up to the clouds are, by being passed through the proper lenses, directed in the focal plane desired. In small lenses like spectacles, where a clear, perfect image is the prime necessity, and the whole thickness of the glass but little, it is made of a single piece of glass, ground so that the two surfaces present the desired angle to each other everywhere. But as continuous lines of great length, and at the proper angle, would of necessity be in some part widely distant from each other, so a lens, of that class, large enough for a lighthouse, would be so thick in some part (and in reality right in the centre, where the effect would be most detrimental) as to seriously obstruct the passage of the light, and the loss in this way would nullify the whole value of the lens. To prevent this, the lantern is provided with small and thin lenses in the line of the focal plane; each of these, again, is surrounded by a series of rings, each ring equivalent in form and action to the thin edge of a lens of larger diameter, but the same refracting power; and this is repeated until the angle at which it is wished to refract the light becomes too great for convenience, when recourse is had to a series of triangular prisms of glass, so placed that the ray of light passing through the first side is reflected from the second, and passes out through the third, in the direction desired. The whole, uniting the reflecting with the refracting classes, becomes what is technically called a catadioptric light. The orders of lights vary with their size and power, examples of various sizes being shown; also lamps of various patterns for burning lard, or coal oils—one great desideratum being to have a lamp that would give a perfectly regular and equal supply of oil to the wick throughout the whole time of burning. Of the various devices for this purpose there are Meade's lamp, regulated by a screw movement; Wagner's, with a clock-work pump supplying the oil, and an overflow for the surplus; Lepante's moderator lamp, having a float upon the oil to govern the supply; and a very ingenious one, known as Funcke's hydraulic float lamp. In this the main oil tank is placed above, so that the natural flow will supply the lamp; this flow between the tank and the lamp passes through a small valve chamber, wherein is a small float regulated to (when just on the level of the oil in the lamp proper) close a small puppet valve stopping the flow, but as the oil burns out the float drops, opening the valve and admitting a fresh supply. There are also a series of full-sized photographs of the flame of this lamp, of all the sizes of the different orders. Also samples of wicks, oils, measures, brushes, and all of the plant of a well-regulated lighthouse.

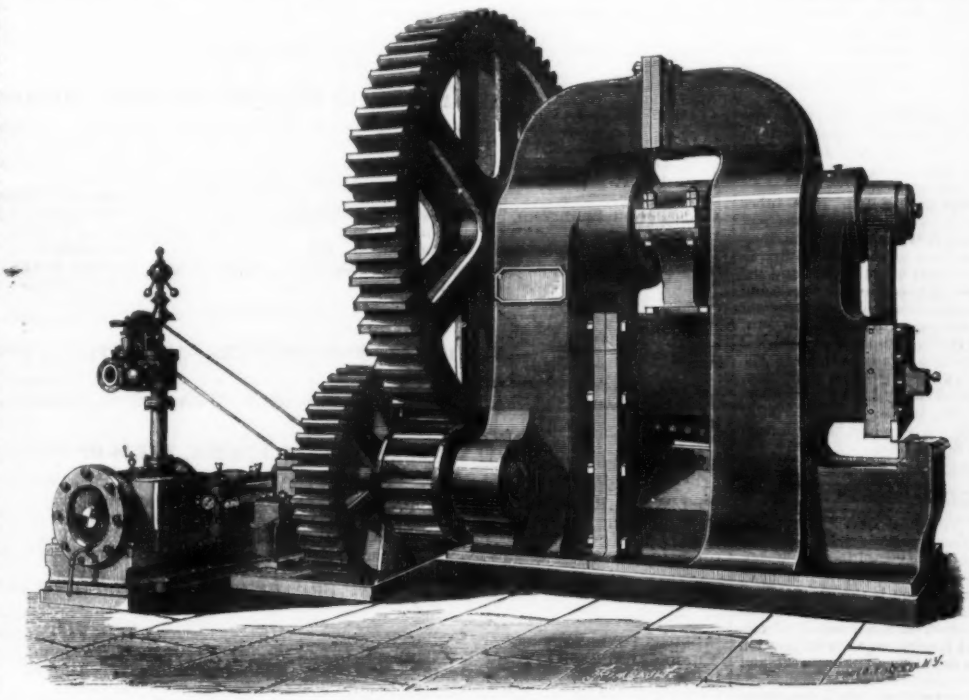
PHOTOMETER.

Here is also a photometer, or light-measuring apparatus, in reality a triple machine, so that three observers can measure the value of a sample of oil at once. The standard for measuring the value of oil for illuminating purposes is a certain amount of wax candle, burned in a given time; the candle is burned and weighed at the same time that the oil is also burned. The lamp and candle are placed at the opposite ends of a long wooden bar that is graduated, and carries a small sliding carriage; on the carriage are two small mirrors set at an obtuse angle to each other, and midway between them is a small screen of ground glass with a small spot in the centre, that is semi-transparent. Turning the screen directly towards one's self and looking on both sides of it, the reflection of the spot is seen near the centre of each mirror. The lamp and candle being provided with covers, pierced by small slits opening towards each other, and the room being darkened, the rays of light from both the lamp and the candle are allowed to fall upon the spot in the screen, in fact to meet there, and neutralize each other; then the observer slides the carriage along, until by the equality of the two images, as seen in the mirrors, the neutralization of the rays is seen to be perfect, and the graduated scale at that point shows the comparative illuminating power of the flame; the carriage of course being nearest to the weakest light, by the usual proportion of the square of the distances, which is accounted for in making the scale. The object and value of the experiment are apparent upon considering the number of the lighthouses, and the amount of oil consumed, making it essential to have the very best article the market can produce.

A FULL-SIZED LIGHTHOUSE.

Besides several models of lighthouses and the foundations of lighthouses, inside of the building there is, a few steps from the United States department, a full-sized lighthouse; it is built of cast-iron, and will, after the exhibition, be placed on the "Ship John Shoal," in Delaware Bay. The plan of the house is octagonal, with a high roof, the lantern being placed upon the centre; the height of the focal plane is to be forty-six feet above the water; the light will be of the 4th order, revolving, and the accommodations for the keepers and their supplies will be complete. By the side of this are full-sized spar and can buoys, the latter looking like steam-boilers, but of an egg or cigar-shaped form; also a large fog bell, cast by Wm. Blake & Co., of Boston, with a clock for striking the signal, made by G. M. Stevens & Co., also of Boston; this being struck occasionally, sends a mournful toll over the grounds, giving the impression that a graveyard is near; and on the other side are the fog sirens—the invention of Felix Brown, New-York—two in number, looking like huge iron trumpets projecting out of a small boiler-house. One of them is really blown by steam, and the other by air blast (having a rotary blower driven by a caloric engine). The principle of these, like the sound, is similar to an overgrown fish-horn; it is said that they can be heard for many miles, and the general impression is that for the purpose of alarming people they are perfect.

A. V.



COLLIER'S SHEARING MACHINE.

COLLIER'S SHEARING MACHINE.

WE illustrate a very powerful machine constructed by Messrs. W. Collier & Co., of Manchester, Eng., for cutting bar iron up to 5 in. square cold, and shearing plate scrap up to 2 in. thick. It will be seen from our engraving that the frame of the machine is cast in two parts, secured together by bolts and steady pins, and is very strong and massive. The two cutting slides are actuated by a steel eccentric shaft, 14 in. in diameter, and it will be seen that the eccentric working the middle knife wherein the 5-in. square bars are cut, is supported close up to its work, on each side of the eccentric, by the main frame of the machine, one half of which is bored out and bushed, the bush being sufficiently large to allow the eccentric shaft to be got into its place. Each shear-slide is provided with a separate stop motion to throw it out of gear instantly without stopping the machine.

The gearing consists of two pairs of wheels, the first pair being 4 in. pitch, 12 in. wide on the teeth, and the second pair 6 in. pitch, 15 in. wide on teeth, the large wheel being 11 ft. 4 in. in diameter on the pitch line, and weighing 8 tons.

The steam-engine has a cylinder 16 in. in diameter, with plain slide valves, and a high-speed, quick-acting governor. It drives direct on to the first motion-shaft of the machine, and is provided with a heavy fly-wheel. The total weight of the machine is 65 tons, and it has been put to work, giving every satisfaction.—*Engineering.*

PRIME MOVERS.*

ALTHOUGH machines of this kind are, in truth, mere converters or adapters of extraneous forces into useful and manageable forms, and have not any source of life, power, or motion, in themselves, nevertheless they impress us with the notion of vitality; and it is difficult to regard the revolving shaft of a water-wheel or turbine, set in motion by some hidden stream, or to gaze upon the steam-engine actuated by an unseen vapor, without, as I have said, the idea being raised in our minds that the machines on which we are looking are really endowed with some kind of life.

The invention of such machines marks a very great step in the progress of mechanical science in the world, as it commences an era distinct from that in which mere machines to be acted on by human or animal muscular force were alone in existence. Machines such as these, highly useful as they may be, are, after all, only tools or implements more or less ingenious and more or less complex.

Complicated mechanism for the purpose of enabling muscular force to be more readily applied, is of very ancient date. On this point I will quote from only one book—that is, the Bible, where, at the 10th and 11th verses of the 11th chapter of Deuteronomy, a statement is made clearly indicating that in Egypt irrigation was carried on by some kind of machine worked by the foot; whether the treadwheel with water-buckets round about it mentioned by Vitruvius, or whether the plank-lever with a bucket suspended at one end and worked by the laborer running along the top of the lever to the other end (an apparatus even now used in India), we do not know; but that it was some machine worked by the foot is clear; the statement being that when the Israelites had reached the Promised Land they would find it was one abounding in streams, so as to be naturally watered, and that it would not require to be watered by the foot as in Egypt. Again, in Chronicles it is related that King Uzziah loved husbandry, and that he made many engines, unhappily not in connection with agriculture, but for warlike purposes, "to shoot arrows and great stones withal." Further, in the 7th chapter of the Book of Job, we have the comparison of the life of man passing away swifter than a weaver's shuttle; this points unmistakably to the fact that there must in those days have been in existence a loom capable of weaving fabrics of such widths that the shuttle required to be impelled with a speed equal to a flight from one side of the fabric to the other, and no doubt such a fabric must have been made in a machine competent at last to raise and depress alternately the halves of the warp threads. The potter's wheel also is frequently mentioned in the Bible.

Such instances as these are sufficient to show that considerable progress must have been made in the very earliest days of history in the construction of machines whereby muscular force was conveniently applied to an end; but if we leave out of account, as we fairly may, the action of the wind in propelling a boat by sails, and the action of the wind in winnowing grain, I think we shall be right in considering that in the times of which I have been speaking there did not exist any machine in the nature of a power giver or prime mover.

When we come to consider the prime movers of the present day, by which we are enabled to contain within a single vessel and to apply to its propulsion 8000 indicated horse-power, or an equivalent of the labor of nearly 50,000 men working at one time, we find that the prime mover has another and most important claim upon our interest; it enables us to attain results that it would be absolutely impossible to attain by any aggregation of human or other muscular effort, however brutally indifferent we might be to the misery of those who were engaged in that effort.

Excluding from our consideration light, and even electricity, as not being, up to the present time, sources of power on which we rely in practice, there remain three principal groups into which our prime movers may be arranged—namely, those which work by the agency of wind, those which work by the agency of water, and those which work by the agency of heat. But some of these great groups are capable of division, and indeed demand division into various branches.

Water power may be due to the impact of water, as in some kinds of water-wheels, turbines, and hydraulic rams, or to water acting as a weight or pressure, as in other kinds of water-wheels, and in water-pressure engines; or to streams of water inducing currents, as in the case of the jet-pump, and of the *Trombe d'eau*, or to its undulating movements, as in ocean waves. The ability of water to give out motive force may arise from falls, from the currents of rivers, from the tides, or, as has been said, from the oscillation of the waves.

Prime movers which utilize the force of the wind are few in number, and in all cases act by impact.

* Address delivered by F. J. Bramwell, C.E., F.R.S., one of the Vice-Presidents of the Section of Mechanics' Loan Collection.

As regards those prime movers which work by the aid of heat, we may have that heat developed by the combustion of fuel, and being so developed applied to heating water, raising steam, and working some of the numerous forms of steam-engines; or, as in the case of the Giffard injector, performing work by induced currents, by the flow of steam; or we may have the heat of fuel applied to vary the density of the air, and thus to obtain motion as by the smoke-jack; or the fuel may be employed to augment the bulk and the pressure of gases, as in the numerous caloric engines; or we may have heat and power developed in the combustion of gases, as in the forms of gas-engines; or in the combustion of explosives, as in gunpowder, dynamite, and other like materials, used not only for the purposes of artillery and of blasting, but for actuating prime movers in the ordinary sense of the word.

Again, we may have the heat of the sun applied through the agency of the expansion of gases or surfaces to the production of power, as in the sun-pumps of Solomon de Caus and of Belidor, and as in the sun-engine of Ericsson. Finally, we may have the sun's rays applied direct, as in the radiometer of Mr. Crookes.

A consideration of the foregoing heads, under which prime movers range themselves, will speedily bring us to the conclusion that the main centre of all mechanical force on this earth is the sun. If the prime movers be urged by water, that water has attained the elevation from which it falls, and thus gives out power by reason of its having been evaporated and raised by the heat of the sun. If the power of the water be derived from the tidal influence, that influence is due to the joint action of the sun and the moon.

If the prime mover depend upon the wind for its force, either directly, as in windmills, or indirectly, as in machines worked by the waves, then that wind is caused to blow by variations of temperature due to the action of the sun. If the prime mover depend upon light, or upon solar heat, as in the case of the radiometer and of the sun engine, then the connection is obvious; but if the heat be due to combustion, then the fuel which supports that combustion is, after all, but the sun's rays stored up. If the fuel be, as is now sometimes the case, straw or cotton stalks, one feels that they have been the growth of the one season's effect of the sun's rays. If the fuel be wood, it is equally true that the wood is the growth of a few seasons' exercise of the sun's rays; but if it be the more potent and more general fuel, coal, then, although the fact is not an obvious one, we know that coal also is merely the stored-up result of many ages' exercise of solar power.

And even in the case of electrical prime movers, these depend on the slow oxidation—that is, burning of metal which has been brought into the metallic or unburnt state from the burnt condition (or that of ore) by the aid of heat generated by the combustion of fuel.

The interesting lecture-room experiment with glass tubes charged with sulphide of calcium, or other analogous sulphides, makes visible to us the fact that the sun's rays may be stored up as light; but that they are as truly stored up (although not in the form of light) in the herb, the tree, and the coal we also now know; and we appreciate the far-seeing mind of George Stephenson who astonished his friend by announcing that a passing train was being driven by the sun. We know that Stephenson was right, and that the satirical Swift was wrong when he instanced as a type of folly the people of Laputa engaged in extracting sunbeams from cucumbers. The sunbeams were as surely in the cucumbers as they are in the sulphide of calcium tubes; but in the latter case they can be seen by the bodily eye, while in the former they demand the mind's eye of a Stephenson.

ANTI-INCRUSTATION ALLOYS.

By OLIVER HOLDEN, Chicago, Ill.

WHEN iron is in contact with fresh, salt, or acidulated water, or dampness in the earth, oxidization results, and incrustation is formed, especially if the water is subjected to heat. To protect the iron from such incrustation is the object of my invention; and it consists in effecting the result by the application to, or connection with, the iron, of a compound of metals which are electro-positive and electro-negative in relation to iron, as a positive metal and a negative metal attract and protect each other.

This alloy I attach to the iron at convenient points, somewhat distant from each other, by applying it in the form of rivets or bolts inserted in various portions of the boiler or vessel; or in the shape of rings, bands, or plates, which are hung upon the tubes or flues of the boiler, or otherwise fastened to the structure in any convenient manner.

The alloy consists in a compound of zinc, from thirty-three to fifty parts, by weight; tin, thirty-three to fifty parts, by weight; lead, one to ten parts, by weight, and antimony, one to ten parts, by weight. These are combined by melting them together, or by melting separately, and mixing the same, forming a homogeneous metal.

To make a compound of these metals which shall be homogeneous, proper fluxes must be used, and great care exercised in melting, preference always being in favor of a close vessel—as a crucible with cover. First, melt the antimony, keeping the molten metal covered with a flux of powdered borax and resin (each four (4) parts), and one part potash, thoroughly mixed, to which add the lead. Melt the other two metals in separate vessels—the tin first. Then add the flux, and then the zinc. When melted, stir thoroughly with a stick of white wood. Now, pour the molten antimony and lead into the zinc and tin, stirring the whole thoroughly during the pouring out, keeping the mass covered with the flux to prevent oxidization by exposure to the atmosphere.

Different waters require different proportions of the metals.

The rendering of iron electro-negative (and hence preventing its affinity for oxygen) can only be done at some cost or force, but the cost or force required can be regulated by my mixture of metals so perfectly as to make the cost or force almost nothing. To illustrate: When iron is subjected to the action of saline water I would use, zinc, forty parts, by weight; tin, fifty parts; lead, ten parts; antimony, five parts; but, if the same water were above a boiling-heat, I would use—zinc, thirty-three parts; tin, fifty parts; lead and antimony, each one part. In fresh neutral waters I would use—zinc, fifty parts; tin, thirty-three parts; lead, ten parts, and antimony, five parts. In acidulated water I would use—zinc, thirty-three parts; tin, fifty parts; lead and antimony, each, one part; or in proper proportions to resist the action of the liquid in which they may be placed.

THE AMERICAN INSTITUTE OF MINING ENGINEERS has been holding an unusually protracted session in Philadelphia. A great many good speeches were made, and the days of discussions were so alternated with excursions to places where objects of professional interest were to be seen that the session was made pleasurable as well as profitable.

THE INTERNATIONAL EXHIBITION OF 1876.

OFFICIAL LIST OF JUDGES, AMERICAN AND FOREIGN.

I.—MINERALS, MINING, METALLURGY, AND MACHINERY.

AMERICAN.		FOREIGN.	
ALEXANDER L. HOLLEY,	56 Broadway, New-York.	Mr. ISAAC LOWTHIAN BELL, F.R.S., M.P., C.E., Pres't,	Great Britain.
Prof. T. STERRY HUNT, LL.D., F.R.S.,	St. James's Hotel, Boston, Mass.	Mr. ERNST F. ALTHANS,	Germany.
Prof. J. M. SAFFORD,	Tennessee.	Mr. L. SIMONIN,	France.
S. B. AXTELL,	Santa Fé, New-Mexico.	Mr. F. VALTON,	"
JOHN FRITZ,	Bethlehem, Pa.	RICHARD AKERMAN,	Sweden.
AUSTIN SAVAGE,	Boise City, Idaho.	Mr. OCHILLE JOTTRAND,	Belgium.
W. S. KEYES, M.E.,	Eureka, Nevada.	Mr. L. NICHOLSKI,	Russia.
Prof. FREDERICK PRIME, Jr., Sec.,	Easton, Pa.	Mr. NICHOLAS JOSSA,	"
MATTHEW ADDY,	Cincinnati, Ohio.	Prof. Dr. TH. KJERULF,	Norway.
Prof. G. C. BROADHEAD,	Pleasant Hill, Missouri.	Don DAN'L DE CORTAZAR,	Spain.
		EMANUEL PATERNO,	Italy.

II.—POTTERY, GLASS, ARTIFICIAL STONE, etc.

AMERICAN.		FOREIGN.	
General Q. A. GILLMORE, U.S.A.,	Care D. Van Nostrand, New-York.	R .H. SODEN SMITH, M.A., Pres't,	Great Britain.
ARTHUR BECKWITH, Sec'y,	134 Fifth Avenue, New-York.	Dr. G. SEELHORST,	Germany.
Prof. E. T. COX,	Indianapolis, Indiana.	M. DE BUSSY,	France.
General HECTOR TYNDALE,	Philadelphia, Pa.	ADOLF E. NORDENSKIOLD,	Sweden.
HENRY WURTZ,	Hoboken, N. J.	M. K. NOTON,	Japan.

III.—CHEMISTRY AND PHARMACY, WITH THE APPARATUS.

AMERICAN.		FOREIGN.	
Prof. C. A. JOY,	Columbia College, N. Y.	Dr. WILLIAM ODLING, F.R.S., Sec'y,	Great Britain.
Prof. F. A. GENTH,	University of Pennsylvania, Philadelphia, Pa.	Dr. RUDOLPH VON WAGNER,	Germany.
Prof. J. LAWRENCE SMITH, Pres.,	Louisville, Ky.	M. J. F. KUHLMAN (fils),	France.
Prof. C. F. CHANDLER,	Columbia College, N. Y.	M. PROSPER DEWILDE,	Belgium.
Prof. J. W. MALLET,	University of Virginia, Charlottesville, Va.		

IV.—ANIMAL AND VEGETABLE PRODUCTS,—MACHINERY.

AMERICAN.		FOREIGN.	
Prof. W. C. KERR,	Raleigh, N. C.	JULIUS WEGELER,	Germany.
L. B. ARNOLD,	Rochester, N. Y.	Mr. EDOUARD MARTELL,	France.
Colonel J. F. TOBIAS,	1705 Locust Street, Philadelphia, Pa.	Don E. LORING,	Spain.
		Dr. NICOLAU J. MOREIRA,	Brazil.
Colonel JOHN BRADFORD,	Tallahassee, Florida.	M. JAYME BATALHA REIS,	Portugal.
GUIDO MARX,	Toledo, Ohio.	Mr. EKEDA KENZO,	Japan.
RYLAND T. BROWN, Pres't,	Indianapolis, Ind.	E OLDENDORFF,	Argentine Confed
W. S. GREEN, Sec'y,	Milford, Wis.	E. VAN BAUMHAUER,	Netherlands.
		H. G. JOLY, M.P.,	Canada.
		G. F. SECCHI DE CASALI,	Italy.
		Prof. TH. SEGELCKE,	Denmark.

V.—FISH AND FISH PRODUCTS,—APPARATUS OF FISHING.

AMERICAN.		FOREIGN.	
Prof. S. F. BAIRD,	Smithsonian Institution, Washington.	JOACHIM ANDERSEN,	Norway.

VI.—TIMBER, WORKED LUMBER, PARTS OF BUILDINGS.

AMERICAN.		FOREIGN.	
Prof. WM. H. BREWER, Pres't,	New-Haven, Conn.	JNO. R. WEST,	Chili.
J. M. BENNETT,	Weston, Lewis County, W. Va.	M. RODRIGUES DE VASCONCELLOS,	Portugal.
Prof. J. S. NEWBERRY,	Cleveland, Ohio, or Columbia College, N. Y.	Hon. W. SKEAD, Sec'y,	Canada.
		Dr. JOSE DE SALDANHA,	Brazil.

VII.—FURNITURE, UPHOLSTERY, WOODEN WARE.

AMERICAN.		FOREIGN.	
ADDISON BOYDEN, Pres't,	Boston, Mass.	LE MARQUIS DE ROCHAMBEEAU,	France.
CHAUNCEY WILTSE,	Omaha, Neb.	Mr. THEO. SNYERS, Sec'y,	Belgium.
ROBT. MITCHELL,	Cincinnati, Ohio.	FRANCIS THONET,	Austria.

VIII.—COTTON, LINEN, AND OTHER FABRICS, etc.

AMERICAN.		FOREIGN.	
EDWARD ATKINSON, Sec'y,	Boston, Mass.	Mr. ISAAC WATTS, Pres't,	Great Britain.
HUGH WADDELL,	Savannah, Ga.	Mr. W. W. HULSE, C.E.,	" "
Colonel ED. RICHARDSON,	Jackson, Miss.	Don ALVARO DE LA GÁNDARA,	Spain.
A. D. LOCKWOOD,	Providence, R. I.	Major A. GOLDY,	Switzerland.
CHAS. H. WOLFF,	Cincinnati, Ohio.	Prof. GUSTAVE HERRMANN,	Germany.
Colonel SAMUEL WEBBER, C.E.,	Manchester, N. H.	Prof. GUISEPPE DASSI,	Italy.
GEORGE O. BAKER,	Selma, Ala.		

IX.—WOOL AND SILK FABRICS,—MACHINERY.

AMERICAN.		FOREIGN.	
JOHN L. HAYES,	Cambridge, Mass.	Consul GUSTAV GEBHARD, Sec'y,	Germany.
ELLIOT C. COWDIN, Pres't,	New-York.	THEODORE BOCHNER,	Austria.
CHARLES LE BOUTILLIER,	Philadelphia, Pa.	Mr. HENRY MITCHELL,	Great Britain.
CHARLES J. ELLIS,	714 Market St., Philadelphia, Pa.	Dr. MAX WEIGERT,	Germany.
J. D. LANG,	Vassalboro', Maine.	Mr. CHATEL,	France.
H. C. GOODSPEED,	Salt Lake City, Utah.	CARL ARNBERG,	Sweden.
		Mr. HAYAMI KENZO,	Japan.
		Mr. JOHN G. NEESER,	Switzerland.
		AUGUST BEHMER,	Egypt.

X.—CLOTHING, FURS, INDIA-RUBBER GOODS, etc.

AMERICAN.		FOREIGN.	
Prof. W. H. CHANDLER, Ph.D., F.C.S., Sec'y,	Lehigh University, South Bethlehem, Pa.	Mr. DIETZ-MONNIN,	France.
		Mr. MODEST KITTARY,	Russia.
		Mr. EDWARD KANITZ,	Austria.
WM. O. LINTHICUM,	174 Fifth Avenue, New-York City.	Mr. M. P. EMPEY,	Canada.
BENJ. F. BRITTON,	New-York City.		
Dr. GEORGE HEWSTON, Pres't,	Folsom Street, San Francisco, Cal.		
Prof. E. N. HORSFORD,	Cambridge, Mass.		

XI.—JEWELRY, WATCHES, SILVERWARE, BRONZES, etc.

AMERICAN.		FOREIGN.	
MARTIN P. KENNARD, Pres't,	Boston, Mass.	G. H. HEAP,	Tunis.
PETER GOTTESLEBEN, Sec'y,	Denver, Col.	ROULLEAUX DUGAGE,	France.

XII.—LEATHER AND MANUFACTURES OF LEATHER, etc.

AMERICAN.		FOREIGN.
Gov. F. H. PIERPONT, Pres't,	Fairmount, Marion Co., W. Va.	
JOHN CUMMINS, Sec'y,	Boston, Mass.	
THOMAS MILES,	Philadelphia, Pa.	
J. P. POSTLES,	Wilmington, Del.	

XIII.—PAPER, STATIONERY, PRINTING, AND BOOK-MAKING.

AMERICAN.		FOREIGN.	
JAMES M. WILLCOX, Ph.D., Pres.,	Glenn, Millz, Pa.—1722 Spruce Street, Philadelphia.	Sir SYDNEY H. WATERLOW, Bart., M.P.,	Great Britain.
C. O. CHAPIN,	Springfield, Mass.	G. W. SEITZ,	Germany.
WM. FAXON,	Hartford, Conn.		
EDWARD CONLEY,	Cincinnati, Ohio.		
H. T. BRIAN, Sec'y,	Government Printing Office, Washington.		

XIV.—APPARATUS OF HEATING, LIGHTING, etc.

AMERICAN.		FOREIGN.	
C. C. COX, M.D., LL.D., Pres't,	Washington, D. C.		
AZEL AMES, Jr., M.D., Sec'y,	Wakefield, Mass.		

XV.—BUILDERS' HARDWARE, TOOLS, CUTLERY, etc.

AMERICAN.		FOREIGN.	
CHAS. STAPLES,	Portland, Me.	Hon. J. BAIN, Lord Provost of Glasgow,	Great Britain.
DANIEL STEINMETZ, Pres't,	Philadelphia, Pa.	Mr. D. MACHARDY,	" "
GEORGE L. REED,	Clearfield, Pa.	Mr. DIEFENBACH, Sec'y,	Germany.
General JOHN D. IMBODEN,	Richmond, Va.		

XVI.—MILITARY AND SPORTING ARMS, WEAPONS, etc.

AMERICAN.		FOREIGN.	
Colonel S. C. LYFORD, U.S.A.,	(Chairman Governm't Board, etc.)	Major WM. H. NOBLE, R.A., Sec.,	Great Britain.
Gen'l H. L. ABBOTT, U.S.A., Pres.,	Willetts' Point, N. Y.	Capt. COMM'T OF ARTILLERIE LESNE,	Belgium.
GEORGE A. HAMILTON,	St. Paul, Minn.	Capt. L. F. SALDANHA DA GAMA,	Brazil.

XVII.—CARRIAGES, VEHICLES, AND ACCESSORIES.

AMERICAN.		FOREIGN.	
THOS. GODDARD,	Boston, Mass.—134 State Street.	Mr. GUIET,	France.
B. F. MORSE,	Augusta, Me.	Mr. DUFUS,	Canada.

XVIII.—RAILWAY PLANT, ROLLING STOCK, ENGINES, etc.

AMERICAN.		FOREIGN.	
Colonel ROBT. E. RICKER,	Elizabeth, N. J.	Capt. DOUGLAS GALTON, R.E., C.B., F.R.S., Pres't,	Great Britain.
General T. A. MORRIS.	Indianapolis, Ind.	Mr. ERNEST PONTZEN,	Austria.
FELICIAN SLATAPER, Sec'y,	Pittsburg, Pa.	Mr. E. E. A. SCHAAR,	Belgium.

XIX.—VESSELS, AND APPARATUS OF TRANSPORTATION.

AMERICAN.		FOREIGN.	
ISAAC NEWTON,	New-York.	Colonel F. H. RICH, R.E.,	Great Britain.
J. W. GRIFFITH,	Portsmouth, N. H.		

XX.—MOTORS, HYDRAULIC AND PNEUMATIC APPARATUS.

AMERICAN.		FOREIGN.	
C. T. PORTER,	Newark, N. J.	Mr. W. H. BARLOW, C.E.,	Great Britain.
JOS. BELKNAP,	New-York.	Prof. REULEAUX,	Germany.
JAMES MOORE,	Philadelphia, Pa.	NICHOLAS PETROFF,	Russia.
HORATIO ALLEN, Pres't,	So. Orange—"Homewood," N. J.	EMIL BRUGSCH, Sec'y,	Egypt.
CHAS. E. EMERY,	7 Warren Street, New-York.		

XXI.—MACHINE TOOLS FOR WOOD, METAL, AND STONE.

AMERICAN.		FOREIGN.	
IRVING M. SCOTT,	Union Iron Works, San Francisco, Cal.	Mr. JOHN ANDERSON LL.D., C.E., Pres't,	Great Britain.
GEORGE H. BLELOCK,	Springfield, Mass.	M. LE COMMANDANT F. PERIER,	France.
W. F. DURFEE,	Wisconsin (at 56 Broadway, N.Y.).	Mr. C. A. ANGSTROM,	Sweden.
Prof. JOHN A. ANDERSON,	President Kansas State Agricultural College, Manhattan, Kansas.	Mr. AUGUSTE GOBERT, fils, Sec'y,	Belgium.
		Mr. FELIX REIFER,	Austria.

XXII.—MACHINES AND APPARATUS USED IN SEWING, etc.

AMERICAN.		FOREIGN.	
GEORGE W. GREGORY,	Boston, Mass.	Mr. FRED. A. PAGET, C.E., Sec.,	Great Britain.
EDWARD H. KNIGHT, Pres't,	Patent-Office, Washington, D. C.		
L. D. F. POORE.	Springfield, Dakota.		

XXIII.—AGRICULTURAL MACHINES, IMPLEMENTS OF AGRICULTURE, etc.

AMERICAN.		FOREIGN.	
Hon. JOHN P. REYNOLDS,	Chicago, Ill.	Mr. JOHN COLEMAN, Pres't,	Great Britain.
JAMES S. GRINNELL, Sec'y,	Washington, D. C.	Don FERMIN ROSILLO,	Spain.
JAMES BRUCE,	Corvallas, Oregon.	P. D. G. PAES LEME,	Brazil.
		M. MANUEL IRARRAZAVAL,	Chili.

XXIV.—INSTRUMENTS OF MEDICINE, SURGERY, etc.

AMERICAN.		FOREIGN.	
C. B. WHITE, M.D.,	New Orleans, La	W. ROTH, M.D., Pres't,	Germany.
J. H. THOMPSON, A.M., M.D., Sec.,	Washington, D. C.	Dr. ERNST FLEISCHL,	Austria.

XXV.—INSTRUMENTS OF PRECISION, RESEARCH, etc.

AMERICAN.		FOREIGN.	
Prof. JOSEPH HENRY, LL.D.,	Secretary of Smithsonian Institution, Washington, D. C.	Sir WILLIAM THOMSON, LL.D., D.C.L., F.R.S., Pres't,	Great Britain.
Prof. F. A. P. BARNARD, S.T.D., LL.D.,	Columbia College, N. Y.	JUL. SCHIEDMAYER,	Germany.
Prof. J. E. HILGARD,	Washington, D. C.	M. E. LEVASSEUR,	France.
Prof. J. C. WATSON, Sec'y,	Ann Arbor, Mich.	P. F. KUPKA,	Austria.
General HENRY K. OLIVER,	Salem, Mass.	EDW. FAVRE PERRET,	Switzerland.
GEO. F. BRISTOW,	New-York.		

XXVI.—ARCHITECTURE AND ENGINEERING.

AMERICAN		FOREIGN.	
JAS. B. EADS, C.E.,	So. Pass Jetty Works, 122 Common St., New Orleans, La.	Sir J. HAWKSHAW, C.E., F.R.S.,	Great Britain.
		M. EDOUARD LAVOINNE,	France.
General WM. B. FRANKLIN, Pres.,	Hartford Conn.	J. M. DA SILVA CONTINHO,	Brazil.
RICHARD M. HUNT,	49 West 25th St., New-York.	T. G. W. FYNJE,	Netherlands.
Col. GEO. E. WARING, Jr., Sec.,	Newport, R. I.	LOURENCO MAHEIRO, M.E.,	Portugal.

XXVII.—PLASTIC AND GRAPHIC ART.

AMERICAN.		FOREIGN.	
FRANK HILL SMITH,	Boston, Mass.	MR. CHARLES WEST COPE, R.A.,	Great Britain.
JAMES L. CLAGHORN, Pres't,	Philadelphia, Penn.	MR. PETER GRAHAM,	" "
Prof. J. F. WEIR,	New Haven, Conn.	CARL SCHLESINGER,	Germany.
BRANTZ MAYER,	Baltimore, Md.	Dr. H. VOGEL,	"
DONALD G. MITCHELL,	New Haven, Conn.	Mr. T. EMILE SAINTAIN,	France.
GEO. WARD NICHOLS, Sec'y,	Cincinnati, Ohio.	FRITZ L. DARDEL,	Sweden.
Prof. HENRY DRAPER,	New-York University, New-York City.	P. N. ARBO,	Norway.
		Don N. L. VALDEMORO,	Spain.
		Mr. TANTARDINI,	Italy.
		GUGLIELMO DE SANCTIS,	"
		Mr. CARL COSTENOBLE,	Austria.
		Prof. V. DAHLERUP,	Denmark.
		S. E. VAN HEEMSKIRK VAN BEEST.	Netherlands.

XXVIII.—EDUCATION AND SCIENCE.

AMERICAN.		FOREIGN.	
Hon. ANDREW D. WHITE, LL.D.,	President of Cornell University, Ithaca, N. Y.	Sir CHARLES REED, Pres't,	Great Britain.
		Mr. RENE FOURET,	France.
D. C. GILMAN, LL.D.,	President of Johns Hopkins University, Baltimore, Md.	Col. JOHN MARIN,	Spain.
Hon. J. M. GREGORY, LL.D.,	Champaign, Ill.		
Prof. J. W. HOTT, LL.D., Sec'y,	Madison, Wis.		

June 3, 1876.

SURGERY.

The Adduction Perspective.—Dr. J. Hock (*Wiener Med. Presse*) explains the reason why the eyes become fatigued by a prolonged use of ordinary opera-glasses. The opera-glass consists of two Galilean telescopes in which the distance of the object glass from the ocular can be changed by means of a screw windlass. The objective is a convex glass of greater, and the ocular a concave glass of less, focus; both glasses give an upright virtual image. The distance of the glasses from each other varies according as the observer is emmetropic or otherwise. For all refractional accommodation of the eye the bulbs are compelled, by the position of the tubes, to assume a parallel direction, but the equilibrium of the internal and external muscles differs according to the individual refraction, therefore the external recti are too severely taxed, and a peculiar sensation of fatigue is soon felt. In addition to this, the distance between the tubes is generally greater than that between the pupils of the eye, hence the eyes do not see through the centres of the concave oculars, but through the inner borders. This has the same effect as looking through prisms with their refracting angles outward, and burdens the external recti muscles still more.

By an "adduction perspective" Dr. Hock means an opera-glass in which the visual lines are changed from their parallel to a convergent direction. This is accomplished by grinding the concave oculars on prisms set in the instrument with their refractory edge outward. Myopes use the weakest, hypermetropes the strongest prisms. Waldstein, the optician, of Vienna, has made such glasses with prisms of one, two, and three degrees. Those of two degrees are best for emmetropes. —*Schmidt's Jahrbücher.*

Pneumatic Method for Relief of Strangulated Hernia.—Dr. Moritz Egger reports the following case in the *Med.-Chir. Centralblatt:* He was called last July to see a female, seventy-nine years old, who was found in bed, suffering from intense abdominal pain, and with knees drawn up. She stated that, up to the present illness, she had always enjoyed good health, but that three days before, while at work in the field, she suddenly experienced abdominal pain, which gradually increased to such a degree at night that assistance had to be called. She had had no passage since the commencement of the attack. The patient presented all the symptoms of intestinal strangulation, with nausea, and the anxious expression of countenance, and on examination a tumor about the size of a hen's egg was found at the site of the right inguinal canal. After giving morphine internally and making warm applications externally, and after an enema, taxis was repeatedly tried without success. The patient refusing an operation, taxis was again tried ineffectually on the following day, when the patient was almost collapsed, and stercoraceous vomiting had set in. The author then introduced a long elastic tube into the rectum as far as it would go, and began to inject air slowly. After a time, the intestinal coils could be seen through the very thin abdominal walls to become distended, and suddenly a peculiar rolling noise, as if the air had overcome an obstruction, was heard, after which the hernia was discovered to have disappeared. Air was then allowed to escape from the tube, and the latter was gradually removed. Half an hour later the patient had a large stool, and then slept; five days afterward she had entirely recovered.

Arsenic in Diabetes.—S. V. Pap (*Wiener Med. Presse*) gives his experience concerning the therapeutics of diabetes mellitus, as follows: 1. Arsenic appears, in most cases, to exert a beneficial effect, which consists in this, that the pathological secretion of sugar is considerably diminished; in many cases, indeed, it entirely disappears. Naturally, as a result of this, all the other symptoms of diabetes, such as thirst, dryness in the mouth, quantity of urine, depression, etc., are improved. 2. The beneficial influence of the use of arsenic is manifested in the lighter forms more rapidly, certainly, and distinctly, than in the more severe forms, with a greater proportion of sugar than four per cent. In the former, the sugar may entirely disappear, which is but rarely the case in the latter. 3. The diminution or the disappearance of the sugar secretion also takes place with a mixed diet. The maxim remains undisputed, however, that the amylaceous foods should, at least temporarily, be limited as far as possible. 4. After the cessation of the use of arsenic months may pass before the disease again returns. One is not secure, however, from relapses. 5. Unpleasant or injurious effects of arsenic were not observed. The appetite was not affected; it was rather improved in many cases. 6. As a contra-indication, one might cite the highest degree of the disease with advanced tuberculosis of the lungs.

Deaths from Snake-bite in India.—Dr. Richards, of the Indian Medical Department, has published an interesting report on snake-poisoning. It appears that, during the year 1873–74, the number of cases of snake-bite reported in the Lower Provinces and Assam was 4,202; of these, no fewer than 3,565 were fatal. Nearly one-half of the cases occurred during sleep. Natives of the lower classes generally sleep upon the ground, and snakes entering the houses often crawl over the sleeper. If he lie quiet, the snake will seldom bite: but if, feeling something cold gliding over a limb, he move it instinctively, the snake turns at once and bites. It is remarkable that the proportion of women bitten was greater than that of men. In Bengal proper, the majority of the deaths are credited to the cobra, while in Behar the krait seems to be most common and most fatal. The dabois, too, does much mischief.—*British Medical Journal.*

The Transplantation and Implantation of Hairs.—An interesting paper on this subject appears in the *Zeitschrift für Biologie*, from the pen of Dr. Ernst Schweninger, of Munich. He gives the following as the results of his numerous experiments: First, that hairs that have been recently extracted, and to the root of which cell-layers of the root-sheath still remain adherent, if brought into contact with freshly-granulating surface, are capable of contracting adhesions with this, and that from this point a process of skinning over may commence, as after cutaneous transplantation. He has further shown that such hair root-sheaths can attach themselves to the iris and continue to grow. The iris, therefore, constitutes an excellent place for conducting experimental researches of this nature.—*Lancet.*

The Marriage of Near Kin.—An interesting fact in connection with this debated question was brought out in the speech made by Sir Edmund Beckett, in his capacity as chairman of the annual festival of the West-End Branch of the Royal Association in Aid of the Deaf and Dumb. He stated that one of the cases requiring assistance from the society was that of a gardener, who had eight children born deaf and dumb. These eight deaf-mutes were the children of cousins; and Sir Edmund Beckett went on to remark on the common occurrence of several deaf and dumb children in one family, and especially in families where the parents, though not deaf and dumb themselves, were cousins.—*British Medical Journal.*

APPARATUS FOR SUBMARINE FOUNDATIONS.

THE construction of the second of the two dry-docks at Pola, by the engineers of the Austrian Marine Department, involved the adoption of special appliances in forming the foundations which were constructed in a depth of water of 56 ft., the rise and fall of the tide, however, ranging only from 3 ft. to 4 ft.

The existing conditions rendered it necessary to devise an apparatus which should be suitable for all the various operations of dredging and laying the foundations on the rock at the depth above mentioned. For this purpose a modification of the diving-bell was found most suitable, communication with the surface being maintained by a telescopic shaft. The size of this bell was determined by that of the concrete blocks employed in the foundations, the largest of these blocks being 6 ft. 6 in. in width, 19 ft. 8 in. long, and 4 ft. 10½ in. thick.

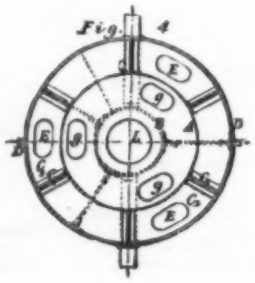
A wooden vessel (Figs. 7, 8, 9) of sufficient strength and stability to sustain the weight of the bell and materials was provided. On this vessel was placed a scaffolding of such a height that when the bell with its connections was raised to its highest position, the bottom edge was on a level with the keel of the boat. The bell was so suspended that it was not affected by the oscillations of the vessel. Examination proved that as a layer of mud only 15 in. thick had to be cleared from the bed rock, it was not considered necessary to resort to dredging, and the mud was therefore removed by hand, filled into tubs, and raised through the upper chambers of the bell. To counterbalance the weight of the bell in its different positions, water ballast tanks were added to the boat fore and aft, and the engines, boiler, etc., were placed upon it so as to distribute the weight as evenly as possible.

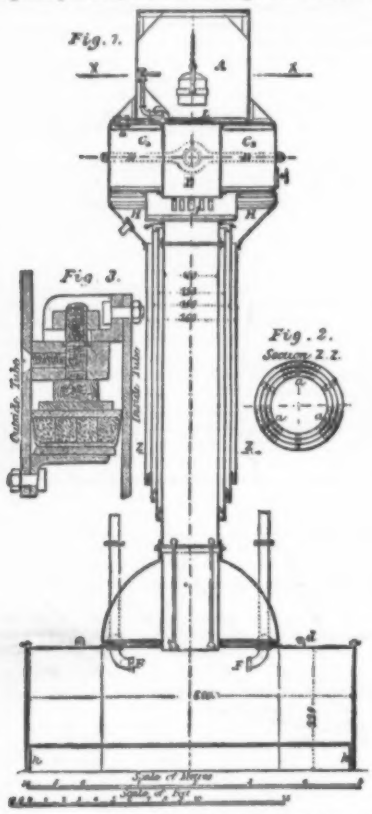
We may commence our detailed description of this special plant by reference to the boat, which was built at the Stabilimento Technico Triestino, near Trieste.

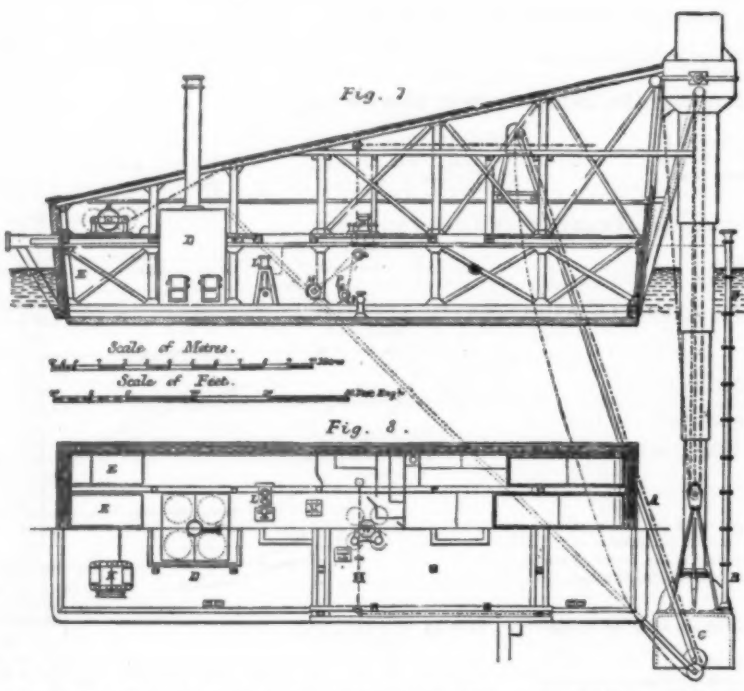
As already mentioned, it was built chiefly of timber strengthened with iron. The form was rectanglar, 85 ft. 3 in. long, and 23 ft. wide, and 16 ft. 4¾ in. deep, the draught, when fully loaded, being 7 ft. 6¼ in., and the displacement 403½ tons. Beams were placed overhanging the stern of sufficient strength to raise the bell, if necessary, when quite full of water. The distribution of the weight was calculated in such a way that the stern of the pontoon with the machinery, boilers, water-tanks, etc., balanced the fore part, as well as the weight of the bell shaft, and all but the last length of this shaft and the bell itself. When employed, the pontoon was hauled to the desired position, and there moored by four anchors. It could then be moved through the short distances required when in work by means of a capstan. This capstan is placed on the deck, its spindle being carried below and terminating in a worm-wheel driven by a worm from the main shaft of the engine. It can also be worked by hand. A spur-wheel is also placed on the capstan shaft which drives four pinions placed around it at equal distances from each other, and the vertical spindles of which pass up through the main deck carrying at their upper extremities small chain drums which of course revolve in a direction opposite to that of the main drum. When it was desired to shift the pontoons, two of the anchor ropes or chains were cast loose, and the other two hauled upon. Two pumps are placed on the pontoon, one worked by hand, and the other, a centrifugal pump, driven by an independent engine. Both pumps are connected to the water-tanks, which are filled or emptied according to the weight of the bell; they are also employed among other purposes for circulating water around the air-pipes to cool the compressed air. Four independent anchors and chains are carried, one at each corner of the pontoon, and below the deck of the latter are placed coal-bunkers and all the necessary sleeping and living accommodation for the men. The scaffolding which carries the bell and its appurtenances is supported upon two longitudinal girders stiffened by diagonal bracing, and covered over on the top so as to form a roof for the lower deck, and to give access to the upper part of the diving-bell, for the supply and removal of materials. The maximum weight which the scaffolding has to carry is 61 tons. The general arrangement and construction of the pontoon is shown in Figs. 7 and 8 on the preceding page.

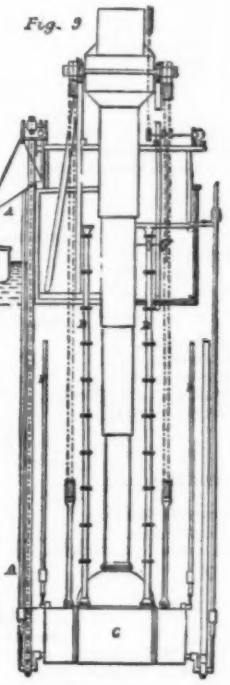
The bell and its various appliances, which are illustrated in the accompanying engravings, were manufactured by the Simmering Company, near Vienna. They consist essentially of the bell, the shaft made in four telescopic lengths, the cover, and the upper chamber. The cover is made of plate and angle iron, and is attached to the scaffolding by two pins, each of which is made strong enough to carry the whole weight.

Fig. 4

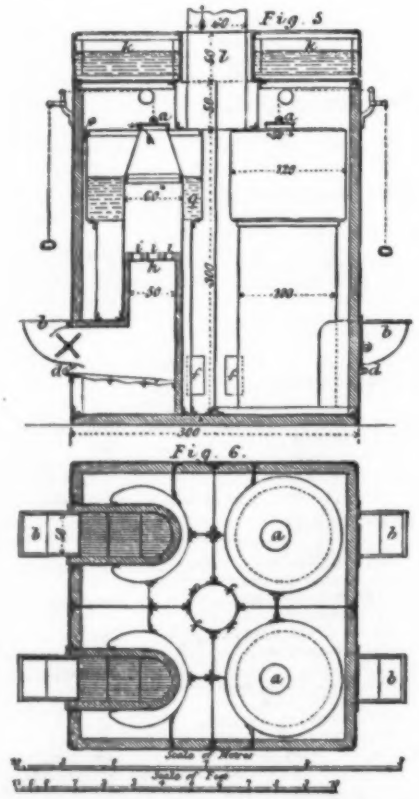








APPARATUS FOR LAYING SUBMARINE FOUNDATIONS AT POLA HARBOR, AUSTRIA.



of foot-bars attached to the inside of the shafts. The projection of these bars is under 4 in., so that they do not interfere with the telescopic action of the sections forming the shaft.

The sections of the shaft are made of wrought-iron plate, circular in form, and riveted up throughout with countersunk rivets. The upper length is fastened to the underside of the upper chamber by an angle-iron ring. It is 5 ft. 3 in. in diameter, and of such a length as to enclose the other three sections when the bell is raised into its highest position. The lower sections can all be fixed in the upper length and to each other, so that one, two, or more of the sections can be worked with the bell according to the depth of water. The stuffing-box at the end of each tube is shown in Fig. 2. It consists of a leather collar closely compressed and fitted to the diameter of the tube. On the collar are placed packing pieces of hemp and tallow, and on the top is laid a rubber ring made in three segments, the whole being attached to an iron ring, and secured by wooden keys bearing against an angle-iron ring; the leather collar also presses against another ring of angle-iron made in six pieces, and bolted to the outside of the shaft. When the apparatus is at work, the air, in exerting a pressure against the leather collar, makes a tight joint, which has proved very efficient in practice; the keys before mentioned are only used to keep the stuffing-box in position when the shaft is being raised. The diameters of the various sections are respectively 63 in., 55.11 in., and 39.37 in., the plates are ⅜ in. thick, and the length about 16 ft. 5 in. The annular space between each pair of the sections is 3.93 in., which is required to allow the plates to clear the foot-bars before mentioned. To prevent the shaft from being turned, the sections are provided with three square iron bars marked *a*, moving in angle-iron guides. Adjustments are provided here to allow of slight oscillation in the tubes.

The bottom section, which is attached direct to the bell, is fitted with rollers bearing against the guide-bars, so as to secure a steady rising and falling motion. The weight of this section is partly supported by chains. The bell itself is a cast-iron box, made in four parts. The top is hemispherical, with doors opening on the inside and attached by screws to the lowest section of the shaft; four bars riveted to this tube carry a wrought-iron ring (*b* Fig. 1), on which the bottom of the hemispherical cover of the bell rests, and this being made rather heavy it serves to some extent as ballast. The special form was adopted in order to provide a space into which the workmen could retire, when the lower part of the bell was being charged with materials through the pipes F (see Fig. 1). The chains to which the bell is suspended pass through the eye-bolts *d*, and are attached to the steam-crane upon the pontoon. Cast-iron plates (*h*) Fig. 1, are placed within the caisson at a height of 15¾ in. above the bottom edge, and serve for ballast as well as to support a movable timber platform which can be shifted at will. The following are the principal dimensions of the bell: Length, 19 ft. 8-13/16 in.; width, 10 ft. 9½ in.; height, 7 ft. 2 11-16 in.; radius of hemispherical top, 5 ft. 3 in. The total cubic contents of bell and shaft is approximately 2000 cubic feet.

These pins are not circular but oval in section, so as to permit slight oscillations to take place in both directions. They rest in cast-iron bearings, bolted between angle-iron girders as shown in Fig. 9. The pins are not attached to the cover direct, but to a ring passing around it so as to distribute the weight over as large an area as possible. The top of the cover is 6 ft. 6¾ in. in diameter and the same height, and it forms the entrance to the shaft. The interior is lighted by four large glass lenses, and in the upper part is placed a windlass, which can be worked either by hand or by rope transmission, and employed to lower the material required. In the centre of the bottom of this compartment is an air-valve (marked L in Figs. 1 and 4), 23.6 in. diameter, which separates this portion from the two lower ones. Ranged symmetrically around this valve are three entrances to the three material chambers C_1, C_2, C_3, Fig. 1, which are closed by suitable valves, and are placed concentrically around the entrance shaft. They are provided with entrance and exit valves in the top and bottom plates. This arrangement is found to be economical, as while one or two of these chambers are being filled with material the remainder can be emptied. The diameter of this part of the apparatus is 9 ft. 10$\frac{1}{16}$ in., and that of the central shaft 3 ft. 3¾ in.; the diameter of the upper part of the chamber being 6 ft. 6½ in., there is left a space within and without 19.7 in. wide for the valves *g* and covers E. In the bottom it is the air-pipe and valves, and this portion is connected to the upper section of shaft by means of an angle-iron ring. By means of pipes fitted with cocks, the compressed air is admitted to the upper and central portions of this chamber, the weight of which, with all its fittings, is 12½ tons. Communication with the shaft is obtained by means of the air-valve L already mentioned, and access to the bell is obtained by means

The weight of water displaced is 56.21 tons, and that of the bell, shaft, fittings, etc., complete is 42.66 tons, so that 13.55 tons of ballast were necessary, the minimum weight of the bell being thus decided. But as the water rises in the bell when the latter is lowered to a height of about a foot, the displacement is reduced by about 6 tons, so that 14 tons of ballast is ample under all circumstances. When in operation, the bell can always be kept in a horizontal position, any deviation from this plane being shown by graduated scales inside, and telegraphic communication between it and the engine-room in the pontoon is provided, so that all signals can be freely transmitted.

The interior of the bell is large enough to allow of the manufacture of a concrete block, 4 ft. 9 in. high, within it, the material, as already stated, being delivered through the supply-pipes F. At the place where these pipes are attached to the top of the bell, a ball-and-socket joint is introduced so as to permit oscillation to take place without damaging the joint. The outlet of each pipe is provided with a foot-valve, and the material being introduced at the upper end, air pressure is applied, and the material is thus discharged and distributed by the workmen in the bell. As soon as one block is completed, the bell is raised to a fresh position alongside, and a new block is formed, the intermediate space being filled with concrete.

The engravings, Figs. 7, 8, and 9, show the mode in which it was intended to apply the dredging apparatus had it been required. From these views it will be seen that the buckets move outside the caisson.

We now come to the other portions of the plant employed on this interesting work, and here we must confine ourselves to a notice only of those which present any special features. The large crane shown upon the pontoon, and employed for raising the bell and shaft, has a maximum lifting power of 60 tons, but this load is only thrown upon it when the bell is lifted quite out of the water; at all other times the weight is reduced by the compressed air. The chains of the crane pass over rollers to the stern of the pontoon, where they are secured. Underneath the crane is placed the feed-water reservoir, which is placed as nearly as possible in the centre of the pontoon, to throw the centre of gravity towards the stern of the pontoon. In the same reservoir vertical boilers inclosed in brick-work and cast-iron plates were used. Steam is generated in four such boilers having 161.4 square feet of heating surface, and 5.38 feet of firegrate area. The boilers are independent of one another, but the products of combustion escape through an uptake. They are cylindrical, with an eccentric internal flue, as shown in the section and plan, Fig. 6. The fire-box is lined with fire-brick, continued to a height of about 65 in. up the flue, and is covered at the top with a circular perforated plate *h*. By means of the damper *a*, the draught can be regulated, and the products of combustion, after passing three times round the boiler, pass up the central chimney. To promote a free circulation in the boiler, an angle-iron is attached spirally around the flue, with the object of preventing the globules of steam as they are formed from rising vertically to the surface, and by causing them to follow the course of the spiral angle iron, to give a circular motion to the water. These boilers were tested to a pressure of 165 lbs., the working pressure being 88 lbs. per square inch. A special feature in these boilers will be found in the fire-doors *b* and the charging apparatus *c*, Fig. 6. The hopper forming part of this attachment is filled with coal, and by turning the shaft on which the vanes of the feeding apparatus are attached, the fuel is gradually fed upon the grate. It should be mentioned that between the brick lining and the boiler there is a space of about 4 in. After the coal fed in by the apparatus upon the front of the bars has been partially coked, it is pushed forward into the body of the fire, and fresh coal is added in front. The feed-water heating apparatus is placed above the boilers; each heater is independent, and is heated by the gases escaping through the damper *a*. The steam-pipes leading to the various motors on the pontoon are fitted with reducing valves to adapt the pressures to the various requirements. The steam-crane is driven with a pressure of about 120 lbs., the air-compressors are worked at 60 lbs., and the other engines at pressures varying from 90 lbs. to 120 lbs. per inch.

The two air-compressors were manufactured by Messrs. H. H. Mahler and Eschenbach, of Vienna. These have been working a considerable time, and have given considerable satisfaction. When working at a speed of 90 revolutions, the delivery is 23 cubic feet per minute at a pressure of 60 lbs. One of these machines is sufficient for supplying the air to the bell, the other being reserved in case of emergency. A tube 2½ in. diameter conveys the compressed air to the bell, and this pipe is surrounded until it leaves the pontoon with a cast-iron tube, through which cooling water circulates from the centrifugal pump already mentioned.

The valves of the pump are so arranged that the latter can draw either from the water-tanks in the pontoon or from the sea. The pump is driven by a compound engine, the high-pressure cylinder of which is 2.95 in. in diameter, and the low-pressure 5.90 in., the stroke being 7.87 in. The working pressure is 120 lbs., and the speed 200 revolutions per minute.

In conclusion we may state that this apparatus has been for some time in successful working at Pola, and no material modifications have been made in the original arrangements, the most important having reference to a greater freedom of the bell to allow for motion in rough weather. We are indebted to Mr. B. Morell, of Berne, for the foregoing particulars.—*Engineering*.

HOW TO BUILD CHEAP BOATS.

By PADDLEFAST.

NO. IV.

A TWELVE-DOLLAR ROW-BOAT.

THIS craft carries but one person. Length, nine feet. It is designed for general use, equally serviceable for rowing, fishing, or hunting, and being very small, can be easily transported. Its small size adapts it for boys' use, and reduces the expense to a minimum. Cost of materials, under $12. Draft, 4 in.

CONSTRUCTION.

The ribs are erected in a vertical plane crossing the keel at right angles. They are marked in Fig. 37 by A, B, C, etc., ⊕, 1, 2, 3, etc., and by the same characters in Fig. 35, which is a combination of cross sections, one at every rib; on the right side showing the forward ribs of one side of the boat, and on the left the after ribs on the other side.

Fig. 35 is to be enlarged to the full size of the boat, and copied in pencil upon a large sheet of stiff paper. First draw indefinite horizontal lines, such as O, I., II., III., IV., V., VI., mutually parallel and 2 in. apart. Perpendicular to these, draw the lines P R and N *q*, mutually parallel and 1 in. apart, and midway between draw the centre line. Now to draw rib

A TWELVE-DOLLAR ROW-BOAT.

E: It begins at the point R, and crosses all the horizontal lines but O. If its intersections with these horizontal lines were determined, its curve could be copied with sufficient fidelity. So, in the enlarged drawing, upon horizontal line I, lay off .9 in. from line P R. This is the distance to the first intersection. Referring to Table 1 below, the distance to the intersection on line II. is seen to be 1.75 in. In the same manner determine the intersections of rib E with lines III., IV., V., and VI. inclusive, but at line VI. the rib is to end for the present. Then draw a line with a gradual curve through

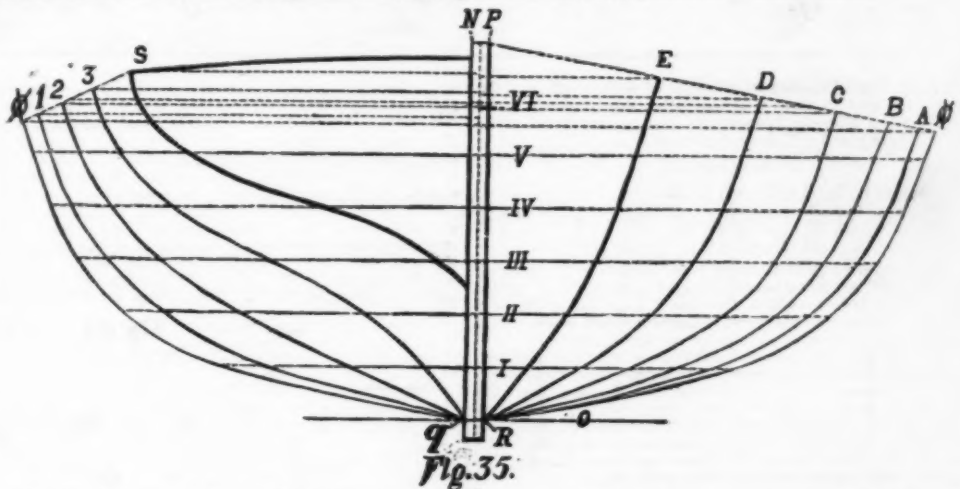


Fig. 35.

the points marked, resting the pencil against a supple oak withe, or a stiff piece of whalebone, bent to accommodate it to the points.

Table 1.

	I.	II.	III.	IV.	V.	VI.	
Rib ⊕	8.90	12.75	14.95	16.17	17.30	.....	
" A	8.45	12.10	14.00	15.15	16.30	.....	
" B	6.70	9.94	11.80	12.90	13.88	.....	
" C	4.45	7.00	8.88	10.00	10.95	.....	
" D	2.35	4.18	5.65	6.68	7.64	.....	
" E	.90	1.75	2.53	3.20	3.85	.....	
" 1	7.76	11.95	14.63	16.05	17.10	.....	
" 2	6.70	9.80	13.38	15.06	16.40	.....	
" 3	4.95	5.80	10.35	13.33	15.05	.....	
Stern	.....	.....	3.70	9.15	12.90	14.20 in.	

Draw the other ribs and the stern by the same method. The stern, however, begins 2 in. above the point *q*, where the other curves commence, or in other words, it begins at the intersection of horizontal line II. with N *q*, though the artist has failed to so represent it.

Thus far the ribs have not been extended above line VI., and some not above line V. The vertical heights from horizontal line O to the tops of the ribs, are given in Table 2. These distances are marked on the centre-line, and from the points so marked indefinite horizontal lines are drawn. On the latter the distances in Table 3 are laid off, and the points so determined give the terminations of the ribs. The upper edge of the stern S is curved to improve the appearance, but it is assumed to be straight, and the height named accordingly. The lines N *q* and P R represent the "stem" or cutwater (shown by F, Fig. 37), the height of which from line O is stated in Table 2.

Table 2.

Rib ⊕	11.04 in.
" A	11.19 "
" B	11.56 "
" C	12.04 "
" D	12.64 "
" E	13.30 "
Stem	14.10 "
Rib 1	11.17 "
" 2	11.57 "
" 3	12.10 "
Stern	12.82 "

Table 3.

Rib ⊕	17.76 in.
" A	16.85 "
" B	14.60 "
" C	11.70 "
" D	8.40 "
" E	4.55 "
" 1	17.76 "
" 2	17.25 "
" 3	16.00 "
Stern	14.35 "

This drawing completed, which shall hereafter be named the working drawing, we may proceed with the construction shown by Fig. 37. The ends are represented more clearly by Fig. 36. G, at the bow, is called an "apron;" F, the "stem;" H, the "bow deadwood;" J J, the "keel." At the stern, S is the "stern-piece;" L, is the "stern post;" K, is the "stern deadwood." The proper direction of the grain is indicated by the shading lines. The stern-piece is here seen edgewise; its face is shown by the working drawing. The fastenings are galvanized nails, shown in the figure by the short cross lines. The upper end of the apron is secured to

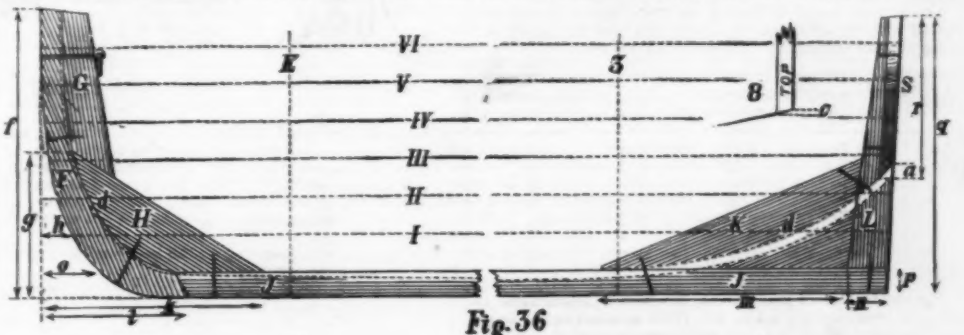
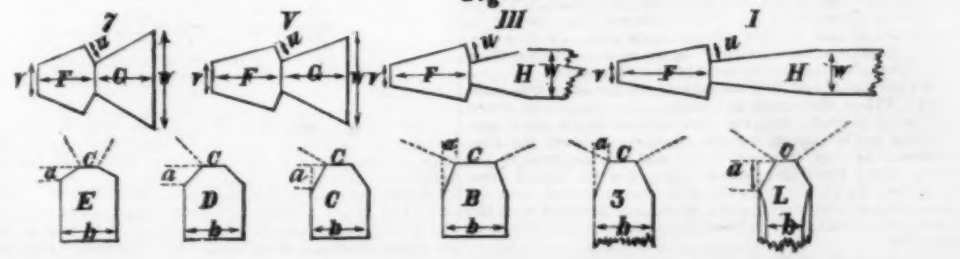


Fig. 36.



the stem by a ring-bolt, also galvanized. Vertical lines E and 3 indicate the position of the ribs so designated.

The cross section of apron and stem at the top is represented in diagram 7 below. Diagram V. shows the cross section of same timbers on horizontal line V., and diagram I. the cross section of stem and deadwood on line I. In these cross sections *u* is the groove or rabbit, which receives the ends of the planks. The same groove is indicated on Fig. 36, by blank space *d d*.

DIMENSIONS.

Fig. 36: *f*, 15.35 in.; *g*, 7 in.; *h*, .45 in.; *o*, 1.10 in.; *k*, 15 in.; *l*, 8.5 in.; *m*, 9.5 in.; *n*, 2 in.; *p*, 1.25 in.; *r*, 10.82 in.; *q*, 14.07 in.

Diagram 7: *v*, .75 in; *u*, .4 in.; F, 1.25 in.; G, 1.25 in.; *w*, 1.96 in.; width of G at junction with F, .75 in.

Diagram V.: *u*, .4 in.; *v*, .75 in.; *w*, 2.04 in.; F, 1.3 in.; G, 1.65 in.; width of G at junction with F, .70 in.

Diagram I.: *u*, .4 in.; *v*, .5 in.; *w*, 1 in.; F, 2.9 in.; width of H at junction with F, .5 in.

The rabbit changes from a vertical to a horizontal position, but beyond the deadwood H, a mere bevel on the side of the keel marks the junction of the planks (diagram E). With the stern deadwood the rabbit recommences and curves up to the stern-piece. The cross section of keel at rib E is given in diagram E. Diagrams D, C, and B give cross sections at the corresponding ribs. The bevel winds, decreasing till at ribs A and ⊕ the bevel is inconsiderable, but increases a little at rib 3 (see Diagram 3). The dotted radiating lines at the top of the keel in these diagrams indicate the future position of the ribs. Diagram L shows the termination of the rabbit in the stern post L. The stern-piece is at C.

DIMENSIONS.

Diagram E: bevel *a*, .11 in.; *b*, 1 in.
Diagram D: *a*, .31 in.; *b*, 1 in.
Diagram 3: *a*, .25 in.; *b*, 1 in.
Diagram L: *a*, .37 in.; *b*, .75 in.

The forward side of the stern piece is given in the working drawing. The edge is bevelled inward from this face. At the bottom, the bevel between the dotted lines *a*, Fig. 36, is 8 inches. At the top, the bevel *c*, diagram 8, is 2 inches. The stern has a slight rake to improve the appearance.

Saw the stern piece from a white oak board. The most convenient way to copy the curves is to lay the working drawing upon the board, and prick through the curved line on the drawing into the wood at intervals by an awl. This marks only the left half of the stern piece. The drawing must then be turned over and placed, as it were, on the right side of the centre line, Fig. 35, and the wood punctured through the same holes, to mark the right half of the stern piece.

After the framework shown in Fig. 37 is completed without the ribs, it is placed upright upon the edge of a board set edgewise on the floor. This board is called the "stocks." It is as long as the boat, 1 inch thick, and about 10 inches wide. It is supported by diagonal braces at the ends, and firmly nailed to the floor on its lower edge. The keel is nailed to the stocks, and stem and stern post erected exactly vertical, tested with a plumb-line, and secured by stays on each side.

This operation completed, we will turn to

THE RIBS.

To bend the ribs, the steaming box, Fig. 38, becomes necessary. It is a box as long as the boat to be built, about 10 inches high, and 4 wide, supported over a large kettle with a wooden cover fitted steam-tight to the inside. Through the cover runs a large tube of wood or of iron, to the box above. The kettle is elevated sufficiently to allow a fire to be built under it. A large auger-hole is bored through the cover, and closed by a plug. One end of the box is open. The boards used should be thick, to prevent warping. The entire apparatus should be made as steam-tight as possible, by caulking or some equivalent operation.

The timber on one side of the boat only is called a rib. Two ribs, one on each side, joined at their lower ends by an additional piece called a "bottom," are technically denominated a "frame."

The ribs of frame E, having so little curve, may be cut curved without bending. The other ribs must be sawed out straight from white oak. Their dimensions are:

Ribs.	Width at upper end.	Width at lower end.	Thickness.	Approximate length.
⊕	.50 in.	.7 in.	.5 in.	28 in.
A	.58 "	.7 "	.5 "	25 "
B	.64 "	.7 "	.5 "	23 "
C	.68 "	.7 "	.5 "	21 "
D	.73 "	.7 "	.5 "	19 "
E	.90 "	.7 "	.5 "	17 "
1	.32 "	.7 "	.5 "	25 "
2	.55 "	.7 "	.5 "	24 "
3	.80 "	.7 "	.5 "	24 "

For every pair of ribs except E, a mould board must be cut, like that shown by Fig. 39. This is nailed to the floor; the ribs are steamed and then bent against its edge.

Transfer the curve of the rib from the working drawing to the board in the manner already suggested. Mark every mould board with the letter or figure of the corresponding rib. Mark the ribs also by their proper characters.

Fill the kettle half full through the auger-hole, and build a fire. When the steam is forming, place one rib of every pair in the steaming box, and close the end with a tuft of hay. With a hot fire, steam for ten minutes. Remove the ribs, bend each against its mould board, and nail the ends to the floor. After remaining a few hours, the rib is held from springing by a cleat (Fig. 39), and then removed from the mould board, care being taken to so place the cleat that the curve will not alter. The other ribs are then bent in the same manner.

It is important to note that the edge of every rib is placed against the mould-board—that is, the side which is uniformly .5 in. wide (see preceding table of dimensions of ribs).

These two edges, or narrow sides, after the rib is removed from the mould-board, are bevelled as in Figs. 40 and 41. Ribs B, C, D, and E, on the starboard side of the boat, are bevelled as in Fig. 40; the same ribs, on the port side of the boat, are bevelled as in Fig. 41. Ribs A, ⊕, and 1 have little or no bevel. Ribs 2 and 3, on the starboard side of the boat, are bevelled as in Fig. 41; and the same ribs on the port side, as in Fig. 40. The amount of bevel, or distance between dotted lines, *a*, Fig. 40 or 41, is:

For pair ⊕	.00 in.
" A	.08 "
" B	.14 "
" C	.18 "
" D	.22 "
" E	.40 "
" 1	.02 "
" 2	.05 "
" 3	.10 "

The above bevels are for the tops of the ribs. The bevels decrease gradually, till at the keel they are zero.

A "bottom" is represented in Fig. 42, showing the manner of connecting the ribs. The angle made between the arms of a bottom may be found from the working drawing. For instance, the angle of the bottom for ribs A is twice the angle between curve A and the centre line on the working drawing. The width of each arm of a bottom, or the vertical thickness, is .7 in.; the horizontal thickness is .5 in. The other dimensions are: (Fig. 43) *u*, 1 in., length of horizontal face, at junction with keel, is equal to the width of keel at the point where the frame is to stand. The position on the keel of every frame will shortly be designated. The length *e* for frame A is 8 in., but toward bow and stern it gradually decreases. The bottoms near amidships are cut from straight-grained wood, but the angles of the bottoms near bow and stern are so acute that they must be cut from knees or tree-stumps, Fig. 44. White oak is the material used. No bottom is made for ribs E. The bottom for ribs 3 is placed on the stern dead-wood, at the point hereafter named, and the dimensions of the bottom must be varied accordingly.

Nail every pair of ribs to the corresponding bottom, 2 galvanized nails to each rib. Then lay these frames upon the working drawing and mark upon them the proper lengths of the ribs. The superfluous lengths are not sawed off yet, however.

The frames are all erected on the keel, omitting ribs E, at the following distances:

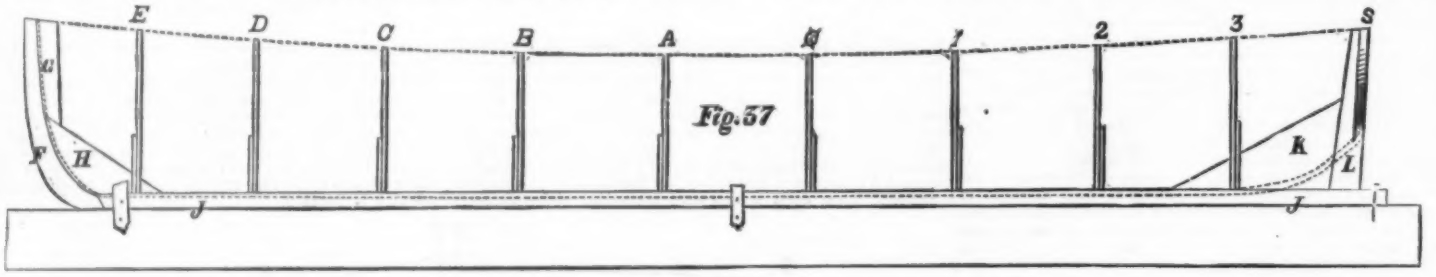
Distance	from stern to	frame 3		9.6 in.
"	" frame 3 "	"	2	10.2 "
"	" " 2 "	"	1	10.8 "
"	" " 1 "	"	⊕	11.4 "
"	" " ⊕ "	"	A	12.0 "
"	" " A "	"	B	12.0 "
"	" " B "	"	C	11.4 "
"	" " C "	"	D	10.8 "
"	" " D "	"	E	10.2 "

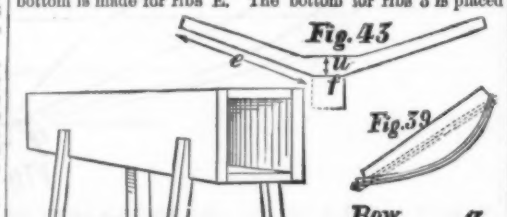
Note that, as shown in Fig. 37, in frames A, B, C, D, the ribs are before the bottom, and in frames ⊕, 1, 2, 3, the ribs are behind. Secure each bottom to the keel by a small galvanized iron bolt.

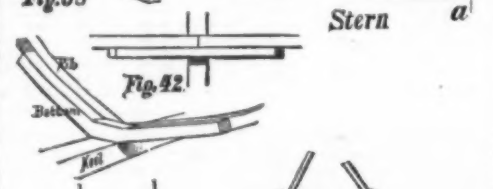
Across every frame connecting the tops of the ribs, place a lath, but before nailing fast draw the ribs in or out, as may be needed to make the width twice that shown on the working drawing, measuring from the centre line on the latter.

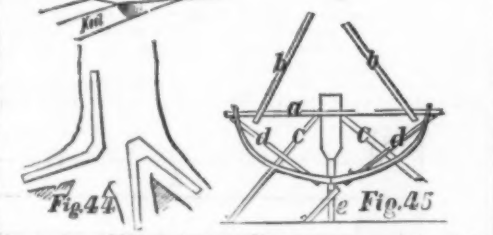
b, b, Fig. 45, are other braces extending from the tops of all the ribs to the roof of the shed. Before they are secured, however, see that the middle point on brace *a* between the ends of the ribs is on a line with the stem and the middle of the stern.

The ribs E are placed in position after the "upper strake" is bent. The bending of the upper strake and the other planks, and every additional operation, will be described in our next issue.









ENORMOUS WATER-FILTER.

MR. LOUIS LESAGE, Superintendent of the Montreal waterworks, in his recent annual report, gives the following:

At the suggestion of some members of the Water Committee, regarding the question of the water supply from a sanitary point of view, and inquiring as to the best means of rendering pure and wholesome the water consumed by the citizens, I was directed to study the question of filtering-basins, and to prepare plans, with estimates of the probable cost, of the best system of filtering as applied to our works. I have since given the subject my attention.

The water used by the city, taken from the River St. Lawrence, is in the spring of the year rendered a little muddy by the freshets occasioned by the melting of the snow, and would require, particularly at that time, to be allowed to settle for a few days before being admitted to the pumps; and I am of the opinion that the construction of a large settling basin near the wheel-house would be all that would be required for the present.

The use of filtering-beds, although very general in Europe, is in America very limited. I am aware of only a few places where such artificial beds are used in the United States. A few years ago, the City of St. Louis commissioned J. P. Kirkwood, Esq., a celebrated hydraulic engineer, of Brooklyn, N. Y., to visit the principal places in Europe where the system of filtration is in use, and to report the result of his observations. It is from the information thus obtained by him that I have studied this question. So far, I am not aware that the City of St. Louis has done any work of the kind.

I herewith submit a description and estimate of a plan which I think would be applicable to our city, should necessity compel us to have recourse to it. It is based upon the same data as those adopted for the City of Liverpool, which data are furnished in the report of Mr. Kirkwood.

From his observations, it is seen that the general practice allowed is about 3 gallons per hour for each square foot of filter beds; and the area of these beds is so divided that one of the divisions may be at rest to allow of its being cleaned. The area of these beds for a delivery of 15 millions of gallons per 24 hours, at the velocity above quoted, would be about 180,000 square feet; this divided into four compartments, would make an area of 45,000 square feet, or a basin of 300 × 150 feet, and each of a capacity of 3,750,000 gallons per 24 hours. The basins here proposed are to be 14 feet deep, built all round with substantial stone walls. These walls are built nearly perpendicular, as those in Berlin and Altona, in Germany, instead of with a slope, as in England (notably at Liverpool). The perpendicular wall is considered as best suited to a climate such as that of Canada. The filtering material is 7 feet 3 inches deep, and made up as follows:

30 inches of fine clear river sand.
6 inches of coarse river sand.
6 inches of ¼-inch gravel.
6 inches of ½ inch gravel.
6 inches of 1-inch gravel.
9 inches of 2-inch broken stones.
24 inches of 4 to 8-inch fragments of stones.

The fragments rest upon a concrete floor of 6 inches in thickness, having a slight inclination towards two lines dividing these basins longitudinally, and these lines towards the outlet where they unite. Along these lines run two openly laid stone culverts, 18 × 24 inches, which unite in a cast-iron pipe under the front wall, communicating with the clear-water well.

The water is to be admitted to these basins from a large receiving reservoir at the back of the filter-beds, and flows over upon the sand, sinking slowly through it and the other filtering materials, and leaving its filth upon the surface of the sand, is gathered by the stone culverts above referred to and conducted to the clear-water wells, in which it rises to the level of the water in the beds, and thence passes over a gate or weir, where it is measured, and its flow regulated by the raising or lowering of the gate by means of proper appliances, and thence passes into the main supply-pipe to the pumps. Over each of the wells is constructed a gate-house, in which is enclosed all the machinery for gauging and regulating the flow of water.

The severity of our winter renders it necessary to have a large area of sand beds, sufficient to filter all the water required during the time they will be covered with ice, as it will then be difficult to clean them. This difficulty might be obviated by protecting the basins from frost by an artificial covering, but the expense of such a plan renders it impracticable.

For this reason, and to avoid the frequent cleaning of the beds, it is important that the water, before being admitted into the filtering basins, should be allowed to settle for a few hours in a gathering reservoir. Fortunately, the winter is the season when our water is the purest, and consequently, when the cleaning of the beds will be least required.

The cleaning, which has to be done from time to time, and the frequency of which experience alone can dictate, is performed as follows: The water of the basin to be cleaned is first lowered to about 12 to 18 inches below the sand-bed, and then a thin coating of about ⅛ of an inch of the upper surface of the sand is removed with flat shovels, by ordinary laborers. This coating is ordinarily found sufficient to remove all the filth gathered on the bed. This dirty sand is wheeled in barrows from the basin to the deposit ground, where it is to be washed for future use, if this process is found to be less

costly than replacing it by new sand. At each cleaning of the filter-bed, the sand has to be loosened by forks for some 6 to 8 inches in depth, and afterwards raked smoothly over; because this sand is liable to pack close if the cleaning is too long delayed, and may occasion the destruction of the bed, by a too great pressure of water resting on, instead of going through a bed so packed. This cleaning may be repeated from time to time, until the sand-bed has been reduced to 8 or 10 inches, without adding new or clean sand at each time.

I herewith submit an estimate of the probable cost of four filtering basins, each capable of filtering 3,750,000 gallons per 24 hours:

COST OF ONE BASIN.

Filter-basin, 300 feet × 150 feet	$92,872 00
Valve-house	6,729 00
Superstructure	2,586 00
Well and inlet-pipe	1,322 00
Piping	3,987 00
Total for one basin	$107,496 00
" four basins	$429,984 00

To which must be added:

Octagon well	4,923 00
Superstructure	2,893 00
Piping to the pumps	3,016 00
Total	$440,825 00

Now, as to the cost of maintaining these filters in proper operation, I have to say that I am not in possession of sufficient information to give very correct figures; and I have to gather from Mr. Kirkwood the cost of such work in Liverpool, which is laid down at £100 sterling per annum per million of gallons filtered daily. On the supposition that the same work could be done here for $500, added to which $2000 for interest on capital expended, makes a total of $2500 per annum for each million of gallons daily, or 365 million gallons at $6.85, or 1000 gallons at $\frac{1}{10}$ of a cent nearly.

FRENCH ACADEMY OF SCIENCES—MAY, JUNE.

On a Quino-acetate of Calcium. By M. E. Gundelach.—On examining a specimen of commercial quinate of calcium, the author finds that this crude salt contains essentially a double salt composed of equal molecules of quinate and of acetate of calcium. He has succeeded in directly obtaining this body by mixing solutions of the above-named salts. If in the quino-acetate solution the calcium be precipitated by oxalic acid, and if the solution be concentrated, acetic acid is disengaged, and quinic acid melting at 323.6° Fah. is deposited on cooling.

On Intra-venous Injections of Chloral as a Surgical Anæsthetic. By M. Oré.—A workman engaged in a machine-shop was injured below the knee by a severe fall. The lesion was located on the anterior portion of the tibia, occasioned great pain, and finally developed into a tumor, the rapid growth of which rendered amputation of the leg necessary. It was decided to place the patient under the influence of chloral, and a $\frac{1}{4}$ solution was prepared, neutralized by the addition of a few drops of carbonate of soda solution. During 8 minutes and 30 seconds, 100 grains of chloral were injected into the veins adjoining the tumor. The patient was in an extreme state of nervous terror; but during the progress of the injection, and when 60 grains had been administered, he gradually became calm. At 75 grains he fell asleep, and finally, when the quantity above noted had been injected, anæsthesia became absolute. Twenty-five minutes after the operation the respiration was regular at 32, pulse 108; 5 minutes later, reflex movements, induced by touching the cornea, appeared. The patient slept calmly for six hours, and on awaking expressed no knowledge of the operation. He is now progressing in every way favorably.

On the Thermic Formation of Ozone. By M. Berthelot.—Ozone is a body formed with the absorption of heat. It disengages this excess of heat in its oxidation, which accounts for its activity superior to that of oxygen. This excess of heat or energy is stored up under the influence of electricity: a remarkable phenomenon is that a body more condensed than its generator results; a condensation generally disengages heat in its ordinary reactions, instead of absorbing it, as is here the case. It is, besides, the first, and the author believes the only instance of a simple gas susceptible of presenting two distinct isomeric modifications in the gaseous state. The thermic properties of oxygen therefore, under its two conditions, correspond with the mode of formation of the latter and their thermic properties.

On the Absorption of Free Nitrogen by Organic Matters at Ordinary Temperature. By M. Berthelot.—The author finds that free nitrogen is absorbed at ordinary temperature by organic compounds under the influence of the electric current (silent discharge). This discovery renders it probable that during storms, or when the air is electrified, organic matter absorbs nitrogen and oxygen. However limited the effects thereof may be, they may well become considerable, through the extent of the reaction universally and perpetually acting.

On the Origin of Organic Ferments. By M. Pasteur.—The author asserts emphatically that organized living ferments arise from living organisms, and that the germs of these ferments are in suspension in the air, or at the exterior surface of objects. The theory of a force of semi-organisms acting on albumenoid matters in contact with the air to produce these ferments is absolutely untenable.

On an International Committee for the Exploration of the Isthmus of Darien, to Determine a Route for a Canal. M. Ferdinand de Lesseps (projector and builder of the Suez Canal) reports that the committee of the Academy on commercial geography has accepted and approved the idea of beginning a topographical, botanical, zoological, and ethnological exploration of the Isthmus of Darien, with the reserve, however, that no nation shall take the initiative in the work, but that it shall be begun through an international committee from all civilized nations.

On the Transparence of Flames and of the Atmosphere, and on the Visibility of Flash-light Beacons. By M. Allard.—The author presents several memoirs relative to experimental and theoretical researches on the above. The flames most generally employed in light-houses are those derived from oil-lamps, having many burners, with concentric wicks. M. Allard finds that the luminous intensities of these flames augment a little more rapidly than does the consumption of oil, and on comparing said intensities with the dimensions of the flames, that the former augment equally with the apparent surface, while they diminish per cubic centimetre (.06 cubic inch) in proportion as the total volume of the flame becomes greater. These results can only be explained by a defect of transparency of the flames. Different experiments lead to the adoption of the number 0.80 as the average value of the coefficient of transparency of the flames, referred to the thickness of 1 centimetre of flame traversed by the luminous rays. From several observations, the author has also determined that there is a state of transparency at which a light ceases to be seen from a given point. In the case of flash-lights, it is demonstrated that in the persistence of the luminous impressions on the retina, the law of decrease of the sensation is represented by an exponential function. The retina then acts like phosphorescent bodies of short period, when they are previously excited by light, and which become rapidly extinguished in darkness, since the law of extinction is the same.

On the Law of Dulong & Petit. (The specific heats of elementary bodies are inversely proportional to their atomic weights.—EDS.) By M. Terreil.—The author considers that there exist two phases only during which bodies possess their true absolute specific heat, from the point of view of the law being exclusively applied to chemistry. The first is at the moment when the body arrives in gaseous state; the second, when the body changes from a gaseous condition. It matters little whether at that instant the body is solid or liquid. It suffices that the change of state occurs. It is further considered, that at the moment of these two phases the forces which modify the absolute specific heats have not yet acted; consequently, in order to distinguish specific heats, as he understands them, from the specific heats considered above, the author gives them the name of "chemical specific heats." M. Terreil has also noted the fact that the specific heat doubles when the bodies cease to be gaseous, as if in losing that state the contraction of matter takes place through molecular agglomeration, representing in volume at the gaseous state a simple ratio with the chemical equivalent, which is in harmony with the law of Gay-Lussac.

On the Duration of the Sensation of Touch. By M. Lalanne.—If a piece of soft material should be rapidly moved around the arm or leg, it would doubtless be thought that an effect would result analogous to that produced upon the eye by rapidly whirling an ignited coal so as to form apparent luminous circles—in other words, that the sensation would be that of a bracelet or ring encircling the member. The author finds by experiment that this sensation of continuity is never manifested under less than ten turns per second. Hence the duration of tactile sensation never exceeds $\frac{1}{10}$ of a second, and is often less, the least observed being $\frac{1}{17}$ to $\frac{1}{10}$ second. He thinks therefore that persistence of vision, hearing, and touch are to be considered as phenomena of similar nature.

TOBACCO CULTURE IN PENNSYLVANIA.

By JOHN ALFRED WITMER, Ph.G.

THE cultivation of tobacco was not carried on to any great extent in Pennsylvania previous to the late civil war; since that time it has increased very considerably. The author's personal acquaintance with the culture of this commodity is limited to Lancaster County, Pa.

The seeds which have been collected the previous autumn are sown (in early spring) in cold frames. These frames consist of large oblong boxes, without bottoms, two or two and a half feet deep by three feet wide, and covered with glass. They are prepared in autumn by being filled with rich earth and fertilizers. In selecting a site for these frames, a sheltered spot having a southern exposure is preferred. They are additionally protected from the weather by being covered with straw, etc. Persons making "plant-raising" a specialty, sow as early as the 15th of February. After sowing, the frames are covered with glass alone during the day, and sheltered at night. The earth being kept moist, the seeds soon sprout, and the little plants appear. Additional care must now be taken to admit the sun during the day and to protect from the frosts at night. Persons not desirous of having plants early or for sale do not take the precautions above enumerated, nor do they sow as early. A warm, sunny spot, having a rich soil, or one enriched by fertilizers, is sufficient for their purposes. When quite young, the plants are frequently infested by the "plant-louse," an insect belonging to the genus "Aphis." When the plants have attained the height of several inches, they are transplanted to the fields. This is rarely done before the 15th of May to the 1st of June. The fields are ploughed the previous autumn, as by so doing it is thought that some of the insect enemies are destroyed. In the spring the soil is loosened, and then ploughed in such a manner as to form ridges one half to one foot high, at a distance of four to five feet apart. The plants are planted on the tops of these ridges, at a distance of two to three feet. A wet day is chosen, as the plants require much moisture to continue their growth without interruption, for at best a large percentage die, owing to want of sufficient care in planting or the ravages of the "cutworm" (different species of the genera Agrotis, Gortyna, etc.), which is the principal enemy at this period of its growth. They are concealed in the earth during the day, and go on their errands of destruction at night, cutting off the plant while it is young and succulent. The only means of preventing the ravages of this enemy is to seek for him in his hiding-place, and when found to kill him. These belong to the order Lepidoptera, or scale-winged insects.

After the plants have been thoroughly rooted, one of the principal objects is to keep down the weeds, which grow luxuriantly in the rich soil. This is accomplished by hoe-harrowing and the hand hoe until the plant grows too large to admit the passage of a horse and harrow without injury to the leaves, after which the plant is strong enough to suppress the weeds, when it grows very rapidly, soon attains the height of three or four feet, and puts forth the flowering head. This is broken off when leaves are the object of the cultivator, but when seeds are desired, the inflorescence is left to develop. Cultivators differ as to the proper time to *top* or break off the flower-head; some prefer to top when the stem has six or eight leaves, while others think ten not too many. After being topped, axillary branches are put forth, which are popularly known as "suckers." These are broken off as soon and as often as they appear. The whole plant is now covered by a viscid, resinous substance, commonly called "gum," which renders it very unpleasant to handle.

About this time tobacco's greatest enemy makes its appearance, namely, the "tobacco-worm" (*Sphinx Carolina*, Linn., different species of genus Macrosilla and others). This, the larva of the "gray American hawk moth," is a green worm, sometimes as large as a man's finger. Allied to this is the *Sphinx quinquemaculata*, of Stevens (also referred to Macrosilla), the larva of which sometimes infests tobacco, but more frequently the tomato and potato. These moths hide themselves and sleep during the day, and at night they go forth to deposit their eggs, in patches of six or more, on the leaves. During the early hours of summer evenings they may be seen hovering over the flowers of the "Jamestown weed" (*Datura stramonium*), from which they extract the exuding juice. By the introduction of some virulent poison into these flowers, numbers of them might be destroyed. These, also, belong to the order Lepidoptera. The larvæ are very destructive to the leaves, and I have known instances in which one worm has eaten an entire plant in a single night. They are watched very closely, picked off by hand, and destroyed.

Of late years a very destructive enemy, in different species of "Arma" (*Arma modesta, macula*, etc.), has been noticed. These belong to the order Hemiptera, or half-winged insects, and deposit their eggs in patches of thirty to fifty. When the young are hatched, they puncture the leaves, and suck the juices of the plant. When a leaf has been punctured by these insects, it rapidly withers, and presents the appearance of having been scalded. As yet no practical method has been adopted for the destruction of this enemy.

When tobacco is *ripe*, or fit to cut, it assumes a peculiar yellowish-green color, and when the under side of the leaf is bent it is brittle, and breaks easily. When in proper condition to be gathered, it is cut off close to the ground, and hung up to dry. Various methods have been proposed for hanging it up, but the most approved, and the one generally adopted, is to pierce the base of the stem by a steel spear, in which is fitted an ordinary plastering lath. By this means five or six stalks are slipped on one lath, and handled and hung up as easily as one. The largest growers have sheds built purposely for drying and curing. These are closed in by alternate boards hung on hinges, so that they may be opened for the free circulation of air on favorable days. Tobacco, when dried and cured, is of a brownish-yellow color, very crisp and brittle, and easily broken when handled, but when moistened it becomes quite pliable.

After the 1st of December the tobacco is "stripped." By this is meant the separation of the leaves from the stems. They are then assorted into two grades, namely, "fillers" and "wrappers." The former consists of "ground" leaves, and those which have been torn or worm-eaten; the latter, wholly of fine, perfect leaves. These names are derived from the relative positions the grades take in cigars. The different grades are then bound into small bundles, by wrapping one leaf around the bases of a dozen others. After being pressed in cases it is ready for market. The term "stripping," as applied by the cultivator, should not be confounded with the same term used by the manufacturer, which refers to the separation of the midrib from the leaf.—*American Journal of Pharmacy.*

THE KENTUCKY MEAT-SHOWER.

To the Editor of the Scientific American:

SIR: In your SUPPLEMENT for July 1st is an article, taken from the *Sanitarian*, on the Kentucky meat-shower, and, introducing the article, you express an opinion that we have therein a solution of the question as to what the substance constituting the meat-shower was, in Mr. Brandeis' assertion that it consisted of masses of nostoc, a low form of vegetable existence. As the public seems to be still interested in the matter, and as, apparently, they have not yet learned what it really is, permit me say a few words thereon. We have in the city of Newark, N. J., an active, wide-awake organization known as the Newark Scientific Association, at the meetings of which novel scientific matters are discussed and sifted. At one of our meetings, for the first time, the true solution of Mr. Edison's so-called "etheric force" took place; and at our meeting in March last the Kentucky meat-shower was discussed, and at that time I made a communication reviewing what was known with regard to so-called showers of meat, blood, and colored matters generally. At that time, and before I had seen any specimens from Kentucky, I expressed an opinion that it would turn out to be nostoc. When, then, I saw Mr. Brandeis' communication, I felt convinced that he had solved the problem, and knowing him well, I called on him to see if he could give me a specimen of the original article. He kindly placed his whole supply in my hands, and informed me that it had been received from Prof. Chandler, who gave it to a physician in Brooklyn, who in turn gave it to him, Mr. B. Soon after, Dr. Allan McLane Hamilton published a letter in the New York *Medical Record*, wherein he said that he had received a piece of the Kentucky shower from Prof. Chandler, and a microscopic examination of it by himself and Dr. J. W. S. Arnold revealed the fact that it consisted of lung tissue either from a human infant or a horse, the structure of the organ in these two cases being very similar. At once I called on Dr. Hamilton, and he likewise placed his specimens in my hands, at the same time informing me that two morsels of the shower had been sent from Kentucky to the editor of the *Agriculturist;* that gentleman placed them in the hands of Prof. Chandler. One went to Dr. Hamilton, the other to Brooklyn, and eventually into the hands of Mr. Brandeis. So I evidently had the whole matter in my possession. On examination I found Dr. Hamilton's specimen to be, as he stated, lung tissue, in one portion of which cartilage was to be seen beautifully exhibited. Mr. Brandeis' specimen, when examined by means of the microscope, turned out to be lung tissue also, but not in as good a state of preservation as the first mentioned. Soon thereafter I was shown by Prof. J. Phin, of the *American Journal of Microscopy*, a prepared specimen sent from Kentucky to Mr. Walmsley, of Philadelphia, which was undoubtedly striated muscular fibre. And subsequent thereto he showed me another specimen sent to him by Mr. A. T. Parker, of Lexington, Ky., which was also striated muscular fibre. Being determined to follow the matter up, I wrote to Mr. Parker, and he very kindly sent me three specimens, two in the natural state as they fell, and one prepared and mounted for the microscope. The last-named consists entirely of cartilage; one of the others is likewise a mass of cartilage, while the remaining portion shows a few striated muscular fibres, along with what appears to be dense connective tissue, but in such a condition that its exact character can not be well made out. I am promised further specimens and information by Mr. Parker, who has been unsparing in his endeavors to elucidate the mystery, whilst he has been at the same time extremely liberal in the matter of distributing specimens. So much for the facts. Every specimen I have examined has proved to be of animal origin, showing that the Kentucky shower was a veritable "meat" shower. As to whence it came I have no theory. Mr. Parker informs me that the favorite theory in the locality is, that it proceeded from a flock of buzzards who, as is their custom, seeing one of their companions disgorge himself, immediately followed suit. In fact, such an occurence has been actually seen to occur, so that it would seem that the whole matter is capable of a reasonable and simple explanation, and we may expect to hear of similar downfalls in other localities.

Respectfully yours,

A. MEAD EDWARDS, M.D.,

President Newark Scientific Association, Microscopist to the Geological Survey of New Hampshire.

9 GOUVERNEUR STREET, NEWARK, N. J., June.

LESSONS IN MECHANICAL DRAWING.

By Prof. MACCORD, Stevens Institute.

(Continued from page 444.)

No. XV.

As an exercise in the drawing of circular arcs tangent to right lines, and in the determination and execution of shadow lines when thus composed, we give in Fig. 134 an ornamental device, somewhat resembling those shown in Figs. 124 and 125. In this one, however, there are five equal divisions in the circle; and as a preliminary we introduce Fig. 135 to show the method of making this subdivision, or in other words, of inscribing a regular pentagon in a circle.

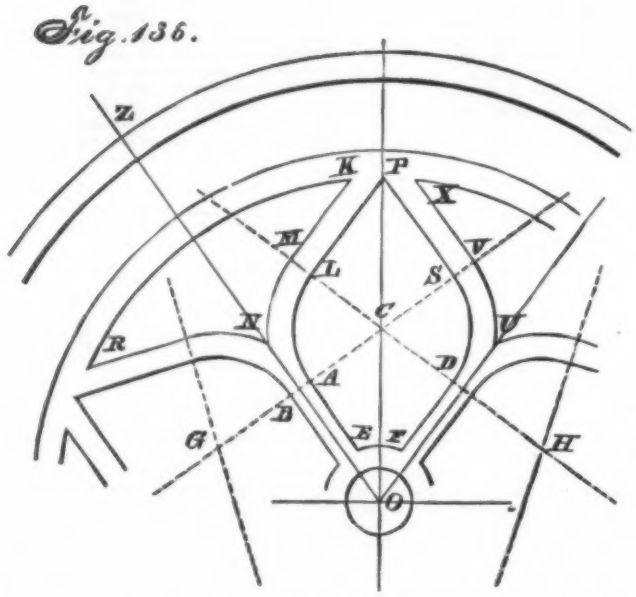
Let O be the centre, A B the horizontal centre line, C D the vertical; bisect the radius O B in E; (this operation is indicated in dotted lines as performed by the geometrical method of Fig 85, merely for the purpose of keeping a record of the steps of our construction, but in practice it may be done by trial and error, or in any other convenient manner.)

With centre E and radius E C describe an arc, cutting A B in F; then with radius C F and centre C describe another, cutting the given circle in G and H; then C G and C H will be two sides of the required pentagon, which is completed by setting off G I, H J, equal to C G.

Fig. 135.

Fig. 134.

Fig. 136.



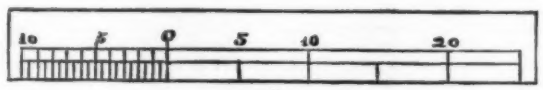
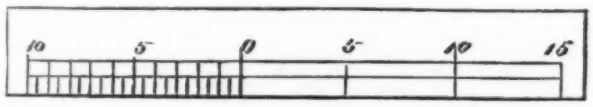


Fig. 137. B.

Fig. 137. A.



In the figure we have shown the pentagon itself in dotted lines merely, as by joining the alternate angles by right lines we form the regular five-pointed star, to which a pleasing appearance is given by drawing it as an open-work frame, which we have done in full lines.

In order to render clearer the construction of the tracery of the window, as we may suppose it to be, Fig. 134, we have given an enlarged view of a portion of it in Fig. 136, in which C G, C H are two sides of a pentagon, prolonged indefinitely, O being the centre of the figure. The side C G is bisected by the perpendicular O N drawn through the centre (just as C O D in Fig. 135 is perpendicular to and bisects I J). We must now first fix on the breadth of the framing, and set off the half of it on C G from this point of bisection each way, thus determining the points A, B. With centre C and radius C A describe the arc A L, terminated by the prolongation of H C, the adjacent side of the pentagon; and also on the other side the similar arc D S. With the same centre C, and radius C B, draw the arc N M; and another similar one U V, outside of D S. Draw L P perpendicular to H M, and S P perpendicular to G V; these two lines should intersect in P on the prolongation of O C. Describe a circle about O with radius O P, and draw M K, V X, to meet this circle. It is to be understood that the same process is to be repeated at each angle of the pentagon, which will result in the formation of five such figures as N K R; and a circle is to be drawn outside the whole, at a distance from P K R equal to A B. Now draw A E parallel to O N, and D F parallel to O U, producing them toward the centre, not till they meet, but until the distance E F is about equal to A B, the precise dimension being of no particular consequence. E F is a circular arc whose centre is O; and within it is drawn a complete circle, the difference between the radii being equal to A B. Having gone all round the pentagon in this way, we have the five irregular figures like P E F which, with the alternating ones like K N R before mentioned, and the central circle, may be regarded as the panes or openings of the window, of which the framework is now completed; a band or moulding may, however, be drawn surrounding the whole, as in Fig. 134.

It will be noticed that the exact distance from O to P depends not only on the size of the pentagon, but on the breadth of the framing A B, and this latter is wholly optional, depending on the taste and judgment of the draughtsman. And it will be a very good exercise for the student to experiment on this for himself; not simply copying the figure as it is here drawn, but, fixing in his mind the steps of the construction, going through with them without looking at the engraving at all until he has completed his outline. And we wish it to be understood that we recommend this as a general rule: we do not wish to be responsible for training any individual to become a mere copyist, but wish our readers to plan and proportion for themselves, and to improve upon the originals, for which we know there is abundant room.

But, having taken any pentagon, and from it worked out this design in a manner satisfactory to his conscience (which may be, and we advise that it should be, done upon any piece of paper that is good for nothing else, in pencil merely, and without the full care as to neatness that would be used were it to be inked in), it may happen, and very likely will happen, that it will prove to be either larger or smaller than it is desired that the finished copy should be. Very well: then we have to make a copy on a larger or a smaller scale, that is all. And now is as good a time as any to begin to make scales for such purposes, and to use them.

In the present case, as good a way perhaps as any is to take O C of Fig. 136, that is the radius of the circle in which the fundamental pentagon is inscribed, or may be, which is very much the same thing, and to divide it into any convenient number of equal parts, as in Fig. 137, A. The number of these is wholly immaterial, but should be such that the smallest elements of the design, as the breadth of the framing, A B, for example, can be readily measured by means of the scale thus formed. This scale may be extended, as shown, until it is long enough to measure the radius of the outer circle, O Z, Fig. 136; and if the divisions of the scale are small enough, this radius will either measure a certain number of them, or may be changed until it does without changing the proportion as compared with the rest of the design to an undesirable extent. Having done this, suppose that O C measures 8 parts on the scale, O Z 21 parts, as in the figure: then, taking the radius of the outer circle in Fig. 134, divide it into 21 equal parts.

We have now a smaller scale, as in Fig. 137, B, and it is clear that if we take eight parts on this as a radius, and describing a circle with it, construct the inscribed pentagon, its size will be to that of the outer circle in Fig. 134, in the same proportion that O C has to O Z in Fig. 136; and so with regard to other parts of the design—if we measure any part of Fig. 136 with the first scale, and lay it off on Fig. 134 with the second one, the reduction will be in the same proportion. Nor does it make any difference whether it be reduction ascending or reduction descending: we have chosen the latter because we wanted Fig. 136 to be larger than Fig. 134, in order to exhibit the process of construction more clearly, but in the actual execution of the design it would matter little if our rough draught were smaller than we desire the finished copy to be. This mode of operation—that is, the measuring of a drawing by one scale and constructing it by another—is one of very considerable utility. We shall have occasion afterward to speak of it more fully, and also to give more detailed explanations of the construction and use of scales in general; for the present, however, the divisions may be made with sufficient accuracy by the method of Fig. 33.

It may be stated here, that in order to secure the best result, and that in the most expeditious manner, the arcs A L, D S, etc., should all be struck from the different angles of the pentagon in succession, before the compasses are laid down or the radius changed; next the outer ones, N M, U V, etc., with radius B C; in this way we ensure the equality of the breadths of the curved portions of the tracery. Then, L P and M K, perpendicular to M H, should be drawn in succession, as if we draw first L P, then P S, and so on, completing the inner line of our radial panes before drawing the outer ones M K, V X, etc., we have again to adjust the triangles for the latter, which involves a needless waste of time, to say nothing of the fact that it is not so certain that we shall get the lines L P and M K parallel. And so of the lines like A E which are parallel to radii of the circle: those which are parallel to each other should be drawn at the same time. Very probably some of our readers will say, "What is the use of giving these minute directions? simple common-sense will tell any body all this." We only hope that they will all say so; but if there are any who do not, we would say to the others who do, that common-sense is not universal, and that we run the risk of appearing prolix, and of becoming tedious

in repetition, for the purpose of causing all, if possible, to form the habit of systematizing their operations as far as it can be done. And one cardinal rule is, to occupy as little time as possible in adjusting and readjusting instruments, which generally takes longer than it does to draw the lines after they are adjusted. We have already mentioned this more than once in regard to the compasses, pointing out that as many as may be of the circles or arcs of the same radius should be drawn at once; but we may add that as many as may be of the right lines in the same direction should be also drawn before the stationary triangle is moved, when both must be used in determining that direction, as in the case here analyzed. In the actual process of construction, horizontals and perpendiculars, requiring we may say almost no labor in setting the instruments, when the T square is used, may, and in many cases must, be drawn without regard to any such consideration; but in putting the lines in ink it will be found a great saving of time to adopt the same rule in regard to them also.

The outlines having been inked in, with lines of uniform thickness, the shadow lines are to be added as a finishing touch; the points at which they begin and end on the circular arcs being determined, as before explained, by applying the triangle of 45°, and finding the points of tangency, which may be marked, but very lightly, with the pencil, so that the slightest touch of the india-rubber may suffice to erase the marks, all construction lines being removed, and the paper cleaned from dust, etc., before the shadow lines are attempted in ink.

It may be worth while to remark here, that the india-rubber, in the very act of using it, is worn off in little fibres, and both it and the paper being electrically excited by the friction, these adhere to the paper at first, so that after using the rubber, it is always advisable to brush them off with a soft rag, as before recommended. And, for that matter, it is well to make use of this before as well as after applying the india-rubber, in order to get rid of as much of the dust as possible, with as little friction as may be.

In the introduction of the shadow lines, in a drawing which, like Fig. 134, consists of several distinct but similar members, it is hardly necessary to say that care must be taken to preserve uniformity in their thickness. It is evident that if two of the radial panels, for example, be finished with lines of different thicknesses, the effect will be very bad, although the distribution and graduation of the lines in either one, considered by itself, may be perfectly correct.

That is, of course, if the two be similarly situated in relation to the direction of the light. We do not at all mean to imply that the shadow lines on all the rectilinear elements of this figure should be of the same thickness; but on those which are parallel to each other they certainly ought to be. What we mean to impress on the reader is, that the habit should be formed of regarding the drawing as a whole, and of so modulating the shadow lines as to make them harmonize throughout. With a view to this, the attention must not be concentrated upon any particular part of the plan which at the moment is in progress, but each part must be studied in connection with all the others. As in the original inking-in, the circular arcs or other curved outlines should be attended to first, and the right lines drawn afterward, with especial care in regard to making the lines perfectly smooth and continuous. Any fault in this latter particular should be scrupulously rectified before the drawing is called finished.

We append some examples of line-shading, practice in the imitation of which will be found of use in training both the eye and the hand, and it is on this account that they are given here. Without attempting at this stage to go into a full explanation of all the considerations involved, there are one or two leading principles which may properly be stated, that the student may not go altogether blindly according to the copy set for him, and that he may work understandingly in such variations from it as he may elect to make.

In the first place, then, let us consider the case of a plane surface, parallel to the paper, and therefore equally illuminated in every part. If we were making a tinted drawing, this surface would receive a *flat*, or uniform tint; and in line-shading this effect is imitated by ruling the surface with equidistant lines of uniform thickness. The absolute thickness of the lines, and the breadth of the spaces between them, may vary, according to the size of the drawing, the scale on which it is made, and the distance from which it is to be viewed; but whatever they are, the effect when viewed from such a distance that the individual lines are undistinguishable, is that of a uniform tint, and the eye at once recognizes the surface as a plane; any inequality in the spaces or variation in the thickness of the lines will make the surface appear wavy, or curved, or broken—that is, composed of different planes at angles with each other. In the next place, lights and shades are both more intense the nearer the eye is to the surface. Thus, if we stand near a marble building in broad sunlight, the shades and shadows will appear very deep, and the light parts will look very bright; as we recede, both the lights and the shades will diminish in their apparent intensity, until by and by the whole will appear of a nearly uniform tone.

Now, apply this to the case of a plane surface inclined to the paper. If it be in the light, the part nearest the spectator will appear brighter than the part more remote; if it be in the shade, the nearest part will appear darkest.

Without asserting that this principle alone will suffice to account for all the variations in the distribution of light and shade which it is found necessary to make in representing different objects, it is safe to say that it accounts for a great many of them, and that none of them are inconsistent with it.

Fig. 138 illustrates the three cases above-mentioned—it represents a hexagonal prism, in a vertical position. If the reader will hold up his drawing-pencil so as to look squarely at one of its flat sides, it will give him aid, if he needs any, in forming an idea of the position and the object. We see, then, three plane faces of this prism, the central one parallel to the paper, the others inclined to it at the same angles, the one on the right being in the shade, while the other two are illuminated; and the shading is in accordance with what has been explained. Thus the central plane is uniformly ruled with lines, the face on the left is lightest in front, the one on the right darkest in front. Two other circumstances are to be noted: one is, that the general tone of the right-hand face is darker than that of the one on the left, because it is in the shade, and therefore of right it should be darker; the other is, that on both these inclined faces the depth of the tone diminishes from one side to the other by a uniform gradation. This is also evidently in accordance with reason, as the inclination of the planes is everywhere the same, in regard to both the paper and the direction of the light. In the case of a curved surface, like that of a cylinder, which is shown in Fig. 139, this latter condition is changed. The inclination is different in different parts, and, as a consequence, the gradation in the tone is not uniform. It would be impossible, as yet, to explain all the circumstances upon which the shading of this surface depends; but this does not diminish the value of the exercise as affording practice in the drawing of lines.

It will be observed that the gradation is effected by varying the thickness of the lines as well as the breadth of the spaces; and it is in this that lies the particular value of the exercise. The student is advised to begin by shading a small surface, at first with fine lines and uniformly, until he can produce the effect of a flat tint with some degree of certainty; then, laying out a small rectangle, to try to shade that so as to give the effect of an inclined plane, first light, then dark, and to vary the depth of the tone, until he has this also under some sort of control, before attempting to shade a cylinder.

The best mode of operating, it need hardly be said, is to use the T square simply as a fixed base for the triangle to slide on, and do the ruling with the latter. He should vary the exercise in all possible ways, both as to the size of the surfaces, going from small to large, and as to the thickness of the lines used to produce the required effect. It would be difficult, not to say absolutely impossible, to give any rule by which to determine the thickness of the lines to be used in any given case. To illustrate: a cylinder of a certain absolute size may be shaded with very heavy lines, or with those only half as heavy, and be made to look perfectly round in either way. As a general rule, however, it may be stated that coarse lines have the effect of reducing the apparent size of the object represented—as, for example, a cylinder of half an inch in diameter, if shaded in heavy lines, will look like a full-size drawing of a half-inch rod, while, if shaded in fine lines, it will convey the idea of a larger shaft drawn on a reduced scale. It is therefore to be understood that in varying the dimensions of the objects here given as exercises, it is not intended that the student should attempt to vary the shading in the same proportion; he is not, in other words, to *copy* the drawings line for line and space for space on the same or different scales, but to imitate the effect of light and shade as to the gradation and distribution—practice to which he may devote spare moments, and scraps of paper that might otherwise be of no use.

Figs. 140 and 141 are respectively similar to Figs. 138 and 139, and are introduced in order to illustrate the necessity of varying the thickness of the lines used in shading, according to the scale of the work, though not precisely in the same proportion, as we have just remarked; but it is evident that it would hardly do to shade Fig. 140 with lines as heavy as those used in Fig. 138. Fig. 142 represents the interior of a hollow cylinder, split lengthwise through the centre. The surface consequently varies in its inclination to the light, which in all cases is supposed to come in the same direction, in a manner peculiar to itself, and the distribution and gradation of the tone is different from that shown in the other figures accordingly. All this will be more fully discussed in its proper place hereafter. In the meantime, enough has been said to show the advisability, not to say the necessity, of adopting some definite system as to the direction of the light, and adhering to it in the shading of mechanical drawings; for this not only facilitates the operations of the draughtsman, but makes the drawings themselves more intelligible.

In the execution of this shading, it will be found on trial that exceedingly slight variations in the thickness of the lines, as well as in the breadth of the spaces, will make themselves very conspicuous. It will be found a good plan, in proceed-

Fig. 139.

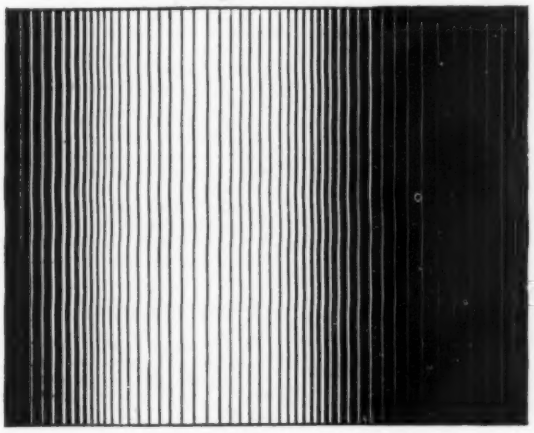


Fig. 138.

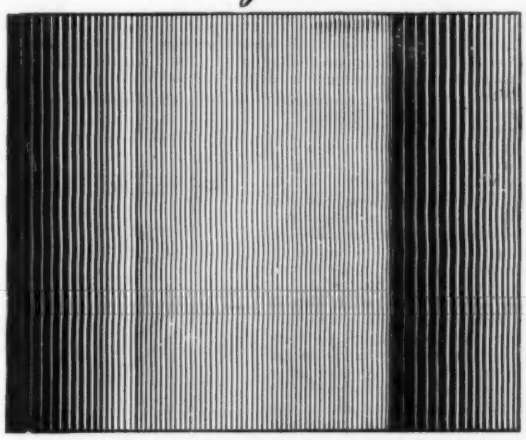


Fig. 141.

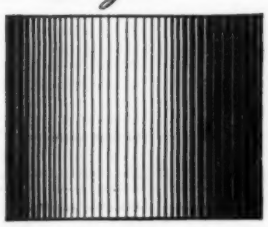


Fig. 142.

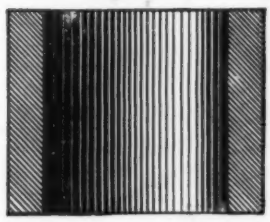
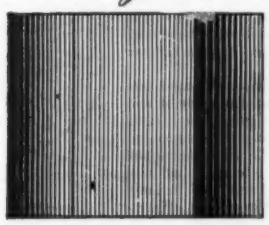
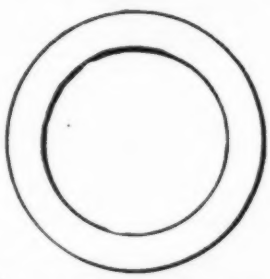
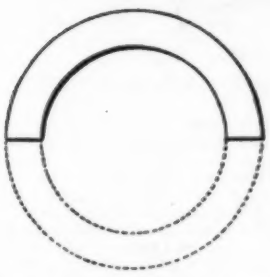
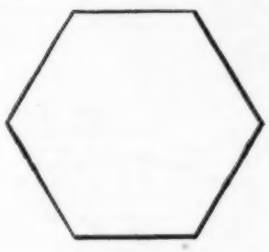


Fig. 140.









ing to shade a surface like that of the cylinder, or the inclined face of the prism, to take a narrow slip of paper, mark on it the breadth of the face, and to shade this in pencil, correcting it by adding the thickness of a line here and there when necessary, until a satisfactory effect is produced. Then lay the slip of paper across the drawing, making the limits of the two surfaces coincide, and adjusting the slip by the triangle till the short lines on it agree with the sides of the instrument which is to be used, and then merely prolonging the lines marked on the slip. Also, it will be found better, in making very heavy lines, not to attempt to set the pen so as to make a mark of the full thickness at once, but to draw two narrower lines, overlapping each other, waiting till the first is dry before drawing the second. The lines should be perfectly smooth, and great care taken to make them terminate exactly in the outline. In spite of all precautions, it is very probable that close scrutiny will show that a space is too broad here or there; which is best detected, not by looking at the drawing from a point too near the paper, but holding it off at some little distance, so as to be able, not to compare space with space across the plan, but to judge of the effect of the whole as a tint. If it appear wavy or irregular, something is wrong, and then we may search from a nearer point of observation for its exact locality; and with a little practice it will be found that the trouble can usually be remedied by adding to a line and subtracting from a space, by merely drawing a new line overlapping the other.

A FLY-WHEEL ACCIDENT.

By JOSHUA ROSE.

EVERY now and then the public is startled by the occurrence of mysterious accidents. In a majority of cases it is the bursting of a boiler, while in many other cases it is the mysterious giving way of some piece of machinery that was supposed to be of ample proportions, in a sound condition, and composed of good materials. If human life has been sacrificed, an investigation takes place, and results, in the ordinary course of things, in nothing being definitely solved and no precise conclusion being arrived at, except it be that nobody was to blame. If, however, nobody has been hurt by the accident, but little interest in the matter is evinced by the public, nor indeed by anybody else save the owner of the engine or boiler, or those who expect to sell to him a new one. Aside, however, from humanitarian considerations, there is a great advantage gained when an accident is unaccompanied by the loss of human life, or the destruction of other people's property; because there is then no incentive for the owner of the engine to throw any mystery around the case in view of prospective suits for damages, and it therefore becomes much more easy to get at the real facts of the case, and therefore to discover the operative causes. The owner himself is under these latter circumstances more deeply interested in the solution of the mystery than either the general public or even scientific engineers. And this is fortunately the case in the matter of the bursting of the fly-wheel of the engine in the brewery of J. & L. F. Kuntz, located at the corner of 168th street and Third avenue, in this city, which occurrence took place at about 10 o'clock on Saturday, June 10th. On visiting the scene of the accident shortly afterward, we were allowed every facility to investigate its causes, and to pursue our own course in the matter.

We found the engine-room to be situated immediately over the boiler-room, the floor of the former constituting the ceiling of the latter. This floor is composed of wrought-iron girders supporting brick arches, and is what is known as a "fire-proof floor." The ceiling of the engine-room is an ordinary board roof having a covering of sheet-tin. The engine is a horizontal one, having a 10-inch cylinder and a stroke of 24 inches, fitted with a plain slide-valve and with a Porter's governor, built under letters-patent issued in July, 1858, and reissued in 1859. The foundation upon which the engine rests is of brick, the holding-down bolts passing through the arches of the floor. The main shaft of the engine, upon which shaft the fly-wheel was keyed, is 5 inches in diameter; the fly-wheel was 9 feet in diameter, and weighed about 3600 pounds.

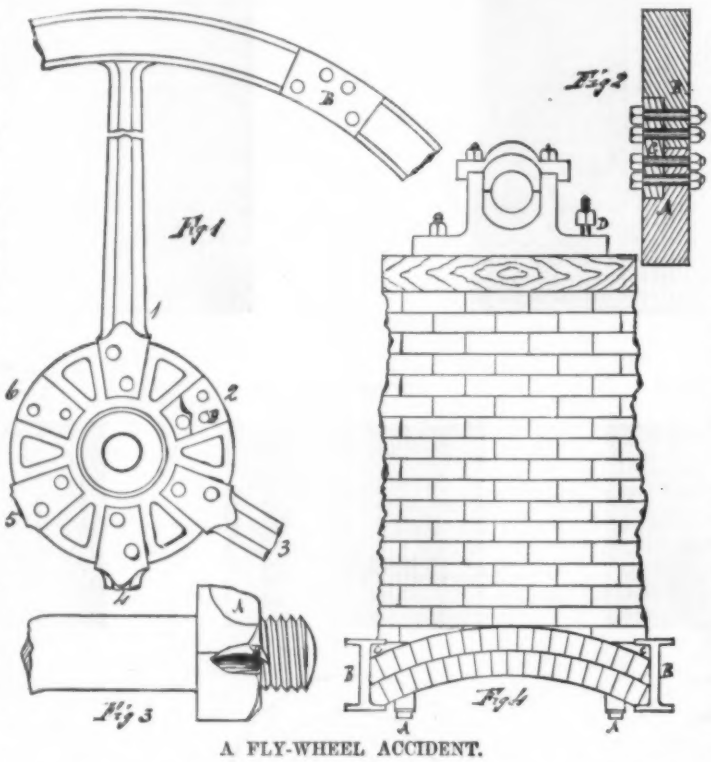
The damage caused by the accident we found to be as follows: Two sections of the rim of the fly-wheel flew through a window, carrying away the sash frame and about a square yard of the brick-work; these sections struck the sidewalk at a distance of about 100 yards, and then bounced about 20 feet, where we found them, with the bolts in them intact. One of the sash weights struck by these sections struck a frame house at a distance of about 105 yards, cutting through the outer framing. Through the ceiling of the engine-house at least one of the sections of the fly-wheel had passed, cutting through four beams, each of about 6 x 3 inches, and finally falling at a distance of about 100 feet away. In the brick-work flooring was another hole of an area of about 6 square feet, through which other parts of the wheel had passed into the boiler-room below. The engine bed is moved about half an inch from its original position upon its foundation, which latter is of brick, and is cracked and bulged in several places.

The statement given to us by the engineer in charge of the engine is as follows: "I had left the engine-room about seven minutes when the accident occurred, and was in the malt-room. I did not notice that the engine ran any faster than usual, our average speed being about 65 revolutions, using 50 pounds of steam per square inch, which was the pressure at the time of the accident. The governor was in good working order, and I am utterly at a loss to account for the accident." In reply to questions, he also said, "Nobody noticed that the engine was running any faster than usual, and the men at the malt-mills would have observed any appreciable alteration of speed. I found the governor belt on the floor beside the engine bed. The floor was springy, and the rim of the fly-wheel only just cleared the flange of the iron floor girders. The boiler was plenty large enough for the engine with easy firing; we never had to force our firing. Our boiler pressure was a steady one. I generally examine the engine before starting her, and have formed no conclusion as to the cause of the explosion."

An examination of the governor belt disclosed that one of its two lacing holes was torn out, and the question arose, Did the lacing break out and the belt slip off, leaving the engine uncontrolled by the governor?—an hypothesis which we understand was vigorously maintained by some of the mechanical visitors. This ground, however, is scarcely tenable, because some of the operatives in the various mills, etc., would certainly have observed any very marked increase in the speed of the machinery; furthermore, the increase of speed necessary under ordinary conditions to create centrifugal force sufficient to burst a wheel of such strength would be something enormous. It is far more probable that when the engine bed moved, the governor pulley, being out of line with the pulley on the main shaft, and the belt running upon the high side of the pulley, as belts do, was stretched until it burst and fell off. Nor is it highly improbable that the engine shifted upon its bed before the fly-wheel burst, because the shifting threw the whole engine out of line, thus creating strains which would prevent the engine from running very fast, and creating a pounding that would have given timely warning that something was amiss; and we were, from these considerations, convinced that the governor had nothing whatever to do with the accident, it being in good working order and in proper repair.

After a minute examination, we came to the conclusion that the cause must be looked for in the fly wheel itself, and a very few minutes' research satisfied us that the cause of the accident was to be found in bad workmanship in the construction of the fly-wheel.

In our engraving, which is carefully drawn in proportion, from actual measurement, Fig. 1 represents the hub and the portions of the arms of the fly-wheel as they appear since the accident, the rim of the fly-wheel being shown above at A, to give a correct idea of the form of the wheel and of the manner in which the rim sections were fastened together. Fig. 2 is a sectional view of the joint of the sections of the fly-wheel, A representing one section and B a second section, the two being bolted together by the plate C, a side view of which plate is shown at B in Fig. 1. On examining this plate we found the holes in it, through which the bolts pass, to be $1\frac{1}{8}$ inch in diameter, while the holes in the fly-wheel sections were an inch in bore, and had been cast in, instead of being drilled. The bolts, however, were $\frac{7}{8}$ inch only in diameter. This was not the case in a single hole only, but in all of them, and a more murderous piece of work it has never been our misfortune to witness.



A FLY-WHEEL ACCIDENT.

In Fig. 3 of our illustration we present a drawing made full size from one of these bolts. Now, it was bad enough to have put $\frac{7}{8}$ bolts into inch holes, but what are we to say when we find that the nut is jammed clear to the very end of the thread—that a slice has been chipped off on one side, as shown in Fig. 3 at A, in the vain endeavor to tighten the nut with a hammer and chisel? Since that remarkable operation, however, the bolt has been given a coat of green paint, and another attempt to tighten the nut with a hammer and chisel has been made, as evidenced by the chisel cut shown in Fig. 3 at B. That the attempt was unsuccessful, the nut itself attests: first, the largest part of its underneath face is covered with a thick layer of black grease; a few projecting spots, however, are bright, not in rings or circles, and not the kind of mark caused by the abrasion due to screwing up a nut very tightly, but that dull, glossy appearance which denotes unfailingly, to the experienced eye, that the nut has had intermittent contact only, and has been loose, instead of binding against its bed. These bright, smooth spots are on one side of the face of the nut only, and the nut has been faced in the lathe so that, if tightly screwed up, the marks should exist all round its surface, whereas the brightest spot is around a burr raised by a third chisel mark made in an endeavor to screw up the nut. As if these defects were not sufficient, the nut is made a very easy fit upon the thread of the bolt, as though the maker of the fly-wheel had been afraid that a single nut upon a bolt, with liberty to wander about in the hole, with the nut jammed up to the end of the bolt thread, and in a position in which it was subject to constant jar and tremble, might, after all, be obstinate, and, contrary to all known experience, refuse to slack back. Under these circumstances, the sections of the rim of the fly-wheel were practically independent weights attached to the spokes of the wheel, the strength of the rim being entirely lost in useful effect, in proportion as the bolts became loose, by reason of the nuts becoming slack. It may not be that all the nuts were slackened, but it is more than probable that a majority of them were, because it is only natural to expect that they would be, for the reasons given above, and the additional one, that the nuts were thinner than they should be, that shown in Fig. 3 lacking $\frac{1}{4}$ inch, at least, of its proper thickness. Of all these blunders, the greatest lies in that the bolts were too small for the holes; and that this was deemed by the constructor as of no consequence, is evidenced by the fact that, while the holes in the sections of the wheel-rim are cast from an inch to $1\frac{1}{16}$ inch in diameter, those in the clamps or plates are drilled an inch. Now, if these latter holes had been drilled $\frac{7}{8}$ inch to fit these bolts a driving fit, the job, though still a very defective one, would have been infinitely better; as it is, a worse one it is difficult to conceive.

We pass now to the outside pillow block shown at Fig. 4. The holding-down bolts shown at A A pass through the brick-work, with a piece of wood interposed between the head of the bolt and the bricks of the arch. No connection of any kind exists between the holding-down bolts and the girders shown at B B, save that afforded by the brick-work, which, not contacting with the upper flanges of the girders at C C, left the pillow block and brick-work to lift and fall at leisure, having simply their weight to act as a foundation. The bed-plate of the engine is bolted to the arches in precisely the same manner, and there is no wonder that it moved half an inch. One of the pillow-block bolts, shown in our engraving at D, has the nut screwed down to the end of the thread, and yet it does not reach within an inch of the pillow block. The edge of one of the girders is (beneath the fly-wheel) abraded away, showing that when the spring of the foundation was at its greatest, the perimeter of the fly-wheel occasionally touched against the edge of the girder, and the same would occur if the lower pillow-block brass wore away much, and was not lifted. The effect of this upon a wheel constructed as this one shows itself to have been, is self-evident. It appears probable that the spokes broke in the order denoted by the figures 1, 2, 3, and 4. The iron, both of the bolts and of the wheel, gives no evidence of crystallization, and appears sound in every part except at spoke No. 2, part of which is left in the hub, which part contains air-holes and looks spongy. This spoke had been broken some time previously, and a third bolt had been, as shown at F, inserted; had it been sound, it would undoubtedly have remained in the hub broken off shorter than spoke 1, but not so short as 3. No. 4 is still shorter than 3, and No. 5 still shorter than 4, while No. 6 is gone altogether; their lengths, with the exception of No. 2, indicating the order in which they broke.

The occasional abrasion of the fly-wheel against the top of the girder undoubtedly operated to assist the nuts in slacking back, but the part abraded gave no signs of any violent blow, and the whole of the evidence pointed to the conclusion that the destruction of the wheel had taken place in the ordinary course of time in which a wheel so barbarously constructed must perforce, in the nature of things, occur.

A NEW THEORY OF THE AURORA.

A RELATION between the polar aurora and terrestrial magnetism has already been pointed out by De la Rive, but the experiment on which the relation is based is not sufficient to account for all the accompanying circumstances of the phenomenon. By carrying a powerful electric current in contact with aqueous masses, thus fulfilling atmospheric conditions, M. Gaston Planté has observed a series of phenomena which he considers are quite analogous to the various phases of the aurora. The results of his experiments he summarizes as follows in *La Nature:*

1. If the positive electrode of a powerful secondary battery be placed in contact with the moist sides of a vessel of salt water, or plunged in, in advance of the negative electrode, there appears, according to the greater or less distance of the liquid contained, either a corona formed of luminous particles disposed circularly around the electrode (Fig. 1), or an arc bordered with a fringe of brilliant rays (Fig. 2), or a sinuous line which rapidly bends and folds upon itself (Fig. 3). This undulatory movement in particular offers a complete analogy with that which has been compared in auroras to the coils of a serpent, or to curves of drapery agitated by the wind.

2. While yellow light dominates in these experiments, owing to the employment of salted water, it is also observed that at such points where the water proceeding from condensed vapor is less charged with salt, purple and violet tints similar to those of the aurora are visible.

3. The rays of the luminous arc proceed from the penetration of the electric current into the liquid, the vacuum which thus results becoming in a measure filled with new rays. This offers an explanation of the jets of light which appear to shoot from the aurora and to renew themselves at every instant.

4. The obscure circle or segment formed in auroras by the mist or nebulous veil, which meets the electric flow, corresponds in the experiment to the moist circle or segment which surrounds the electrode, and around which the voltaic current expands.

5. The arc form in the voltameter occurs when the liquid does not entirely surround the electrode; but if the wire be deeper immersed, waves and entire circles of light are produced, the same as in the auroras, of which the arc is considered as merely the portion visible to the observer of a complete luminous circle.

6. The liquid is violently agitated by the "electric wind"—luminous spirals and rings are formed by the shock of the electrified waves against each other; and if a small amount of liquid be used, a luminous ebullition is finally produced, corresponding to the fluctuation of light, which characterizes polar auroras.

7. Watery vapor is disengaged with rapidity and abundance, in proportion to the penetration of the electrode into the liquid. This phenomenon, of which the strongest electrostatic batteries have hardly afforded a suspicion, is important, for it explains naturally the abundant falls of rain or snow which are always marked during the pendency of auroras.

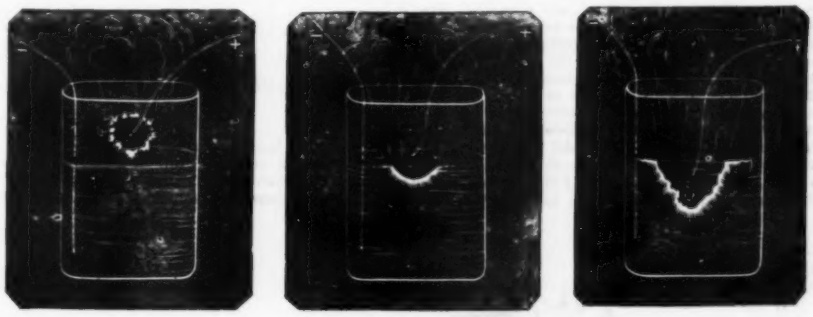
8. The rustling noise which accompanies the experiments corresponds to that often noted during the presence of auroras, when the distance of the same is relatively small. It is due to the vaporization produced by the jets of electric fire penetrating into the humid mass.

9. The magnetic perturbations caused by auroras are reproduced in these experiments by placing a magnetized needle near the circuit. The deviation augments or diminishes according as the luminous arc is more or less developed in the liquid.

10. It appears from these facts that auroras should be pro-

duced by a flux of *positive* electricity, for the luminous phenomena are the same as those of the positive electrode in the voltameter, while the negative electrode offers no similarity of action.

11. But are the polar auroras a discharge between the positive electricity of the atmosphere and that of the earth, which is supposed to be negative? If such were the case, thunder and lightning should be very frequent at the poles, or luminous rays should appear at salient points of the soil, forming the counterpart of the phenomenon occurring in the air. Observation, however, shows these conditions not to exist. M. Planté, however, believes that it is the imperfect vacuum of the higher regions, which, acting as an immense conducting envelope, serves as a negative electrode, and that the positive electricity passes to planetary space and not toward the earth, through the glacial mists and clouds which float above the poles.



ARTIFICIAL AURORAS.

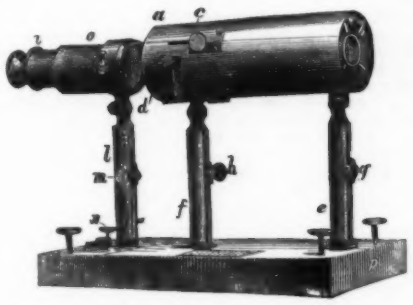
12. With regard to the origin of the polar electricity, it is admitted that it comes from the equatorial and tropical regions. But it may be objected, that the electrified clouds should discharge themselves in so long a journey, and in fact it is known that as the poles are approached storms become more and more rare.

"My previous experiments," says the author, "having brought me to consider the celestial bodies as charged with positive electricity—the only kind of electricity perhaps that really exists—I am inclined to regard the earth itself as charged with positive electricity, becoming disengaged from land and sea by simple emission, and radiated from all the earth's surface, at the poles as well as at the equator, producing effects very different in the atmosphere because of the quite opposite meteorological conditions of that region."

Admitting this last hypothesis, it may be concluded that the polar auroras result from the diffusion in the upper strata of the atmosphere, and around the magnetic poles, of positive electricity emanating from the polar regions themselves, either in rays obscure, when no obstacle interposes itself, or converted into heat and light by meeting aqueous masses in liquid or solid state, which last it vaporizes with noise, and precipitates anew upon the earth's surface, either in form of rain or of snow.

THE DIETHEROSCOPE.

THIS name has been given by M. Lurini to a new instrument for measuring the variations in the refractive condition of the atmosphere. The apparatus is intended for meteorological and geodetical uses, and its construction, which is quite simple, will be understood from the annexed engravings.



Two equal converging lenses are placed with axes coincident, at a distance apart equal to the sum of their focal lengths in the tube *a*, Fig. 1. These produce a reversed image of the object regarded through them, but of a size and at an apparent distance equal to the size and apparent distance of the object itself when viewed by the naked eye.

At *o* is an ordinary spyglass, which gives a non-reversed image. The balance of the instrument consists in adjusting arrangements, briefly described as follows: The tube *a* has a small interior tube *b*, in which the lenses are secured; the screw *c* serves to vary the distance apart of the lenses; *g* and *h* are elevating screws for tube *a*, and the screw *m* serves a similar purpose for the spyglass—the latter, with its supporting column, may also be laterally adjusted by the screw *n*.

It is well known that if a screen be placed so as to cover one half of the objective of a telescope, an object regarded through the instrument will still be seen in its entirety, but less clearly than when the glass is unobscured. If, then, the spyglass in the dietheroscope be so arranged that one half of its objective is intercepted by the tube *a*, it will be obvious that the uncovered portion will still transmit an image to the eye; also, however, another image of the same object will pass through the tube *a*, enter the other half of the spyglass objective, and likewise pass to the eye. Consequently the observer will see two images: first, the upright one, which traverses only the spyglass; second, the reversed one, which traverses both tube and glass, and by suitable adjustment of the instrument both of these images may be rendered quite distinct. The reason of the smaller tube *b* being within the large tube *a* will now be clear from the annexed diagram.

The lens tube *b* covers the upper half of the spyglass objective A, while the space between tube *b* and outer tube *a* being empty, allows of uninterrupted view through; consequently the reversed image will appear above the upright image, and, supposing a candle flame to be projected on a screen through the apparatus, the images will appear as at *c* in Fig. 3. In practice, the tube *a* will be rigidly fixed, the spyglass only movable.

It remains now to describe the use of the invention. Any prominent object, distant a few miles from the observer's station, is regarded, and its two images, by adjustments of the instrument, are brought, for example, upon a single vertical line; now, if during the interval between two observations the atmospheric refraction changes, then the relative position of the images will change; and if the refraction change vertically, they will be displaced vertically; or if laterally, they will likewise be displaced in that direction. To measure the degree of change is an easy matter. Cross hairs may be arranged in the focus of the spyglass, capable of parallel movement, by micrometric screws. Having once determined the angular value of the displacement of each hair corresponding to one turn of its respective screw, it is a simple proceeding to determine the vertical and horizontal distances of a point of the direct image to the corresponding point of the reversed image. The averages of the two angles measured in one observation, compared with those of the two corresponding angles of a previous observation, show the changes of refraction which have occurred during the interval.

For meteorological use, the inventor proposes that at each station four instruments be located, directed to the four cardinal points of the compass. At definite times these are to be consulted and the changes in atmospheric refraction (which may be caused by temperature, wind, dampness, change in barometric condition, etc.) noted at regular periods. The record which could thus be obtained, the inventor considers, would be of great value, especially as it would cover the entire territory within the range of the observer's vision, and not as do thermometric and barometric records—the immediate locality of the station.

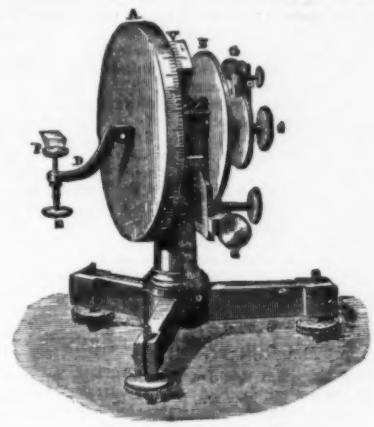
The instrument will find a practical utilization in geodetical observations in supplying a correction for refraction. It has been found, in extended surveys, that observations taken at night have considerably differed from those made by day, owing to the different refractive power of the atmosphere. The dietheroscope, by determining the degree of refractive change during a given period while observations are in progress, affords exact data as to errors attributable to such atmospheric changes.

A CURIOUS ATMOSPHERIC PHENOMENON.

THE annexed illustration from *La Nature* represents a remarkable atmospheric phenomenon observed during a balloon ascension in France not long ago. "At half past four in the morning," says one of the aëronauts, "a magnificent spectacle was presented to our eyes. The moon, which was still shining brightly against the blue of the sky, became surrounded with a resplendent halo—a circle of fire due to the refraction of her light through the ice particles suspended in the atmosphere. The circle was of silvery whiteness and clearly distinguished against the heavens. As we watched it it gradually assumed an elliptical form, and then little by little a cross of light extended its four branches from the moon and completed the wonderful phenomenon. The atmosphere at this time assumed a curious appearance: above the earth a light fog rested, and over it were suspended delicate cirrous clouds which reflected the light, so that they resembled a vast range of mountain peaks losing itself in the horizon. The halo and luminous cross disappeared as gradually as it came, and finally the bursting forth of the sun through the clouds dissipated the last faint traces of the wonderful picture."

THE MEASUREMENT OF THE ANGLES OF CRYSTALS.

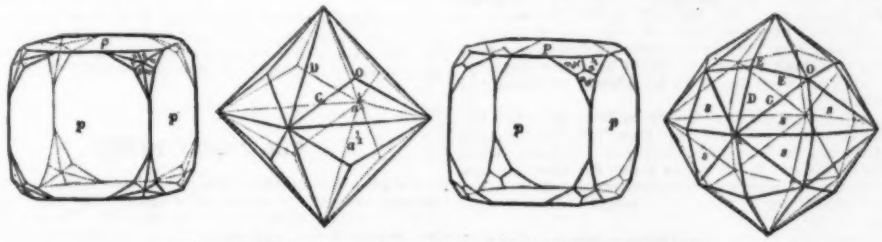
THE crystalline systems, to which are referred all known forms of minerals or artificial saline matters obtained in the laboratory, have recently been described in an extensive work



THE GONIOMETER.

by M. Pisani, of Paris, and the fundamental figures are represented with the forms from which they are derived in a series of illustrations similar to those given below. These figures exhibit the passage of the cube to the pyramidal octahedron and to the scalenohedron—in the second case by three facets, $a\frac{1}{4}$, $a\frac{1}{4}$, $a\frac{1}{4}$, and in the first case by six facets, *s s s*, etc. M. Pisani also describes a reflecting goniometer, an instrument used by mineralogists to measure the dihedral angles of a crystal.

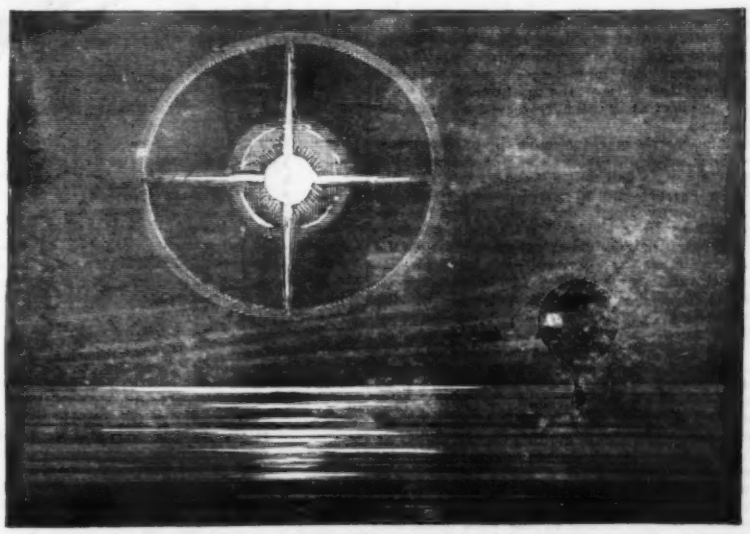
It consists in a circle A, divided into degrees and half degrees, and having a vernier V marked to minutes. The circle is



THE MEASUREMENT OF THE ANGLES OF CRYSTALS.

turned by the disk B. A second disk moves the axis carrying the piece D independently of the circle. This piece is movable normally to the plane of the circle, and supports the platform on which the crystal is placed. G and G′ are adjusting screws for the parts already mentioned.

In order to measure an angle the crystal is secured by wax on the platform in such a position that the ridge of the dihedral angle passes through the axis of the crystal. This position is approximately obtained by movements of the stem F E. The goniometer is then placed on a table at some fifteen feet distant from a candle fixed to the wall. After having determined by the plumb line the foot of the perpendicular passing through the luminous point, two points of view are obtained which are in the same vertical plane. The plane of the circle is then adjusted to the plane of these points. By



AN ATMOSPHERIC PHENOMENON

notes on one face the reflected image of the flame. Then continuing to move the crystal he notes whether this reflected image coincides with the lower point of sight regarded directly. If this coincidence does not occur, if the luminous point appears to the left or right of the point at the lower end of the plumb line, it is made to coincide by the screw E. The coincidence being thus obtained for one face, the other face is adjusted, and when the two images on each face respectively coincide it remains only to measure the angle.

The circle is placed at zero, and by means of disk C the circle is turned until the coincidence of the two points of sight is obtained on the face on the same side as the observer. The eye is kept fixed, and the circle is turned by the large disk B until coincidence is obtained with the second face. The angle through which the circle is turned is the supplement of the dihedral angle, and it remains only to subtract the measurement now from 180° to obtain the required result.

ANILINE BLACK.

MR. JAMES HIGGIN, of Manchester, writes to the *Chemical News* that, without discussing the question as to whether M. Pinkney has or has not discovered vanadium aniline-black, he must recall the fact that John Lightfoot, the inventor of aniline black has pointed out this reaction, and insisted that vanadium is the metal most proper to develop aniline-blacks. All this is perfectly correct, and is found distinctly expressed in an article by John Lightfoot published in the *Moniteur Scientifique*, 362 livraison, February, 1872, p. 109. I will add merely that till lately we had no clear notions concerning aniline-black, and were ignorant of the part played by metals in its formation. Thus Lightfoot first, and then Pinkney, recommend the use of uranium, whose salts only produce aniline-black when they contain traces of vanadium, as I have pointed out, or when they are in the lowest stage of oxidation. On the other hand, Lightfoot states that cerium, molybdenum, and tungsten do not produce black. But cerium contributes to the formation of excellent blacks, and I have found that the salts of molybdenum and tungsten at the lowest stage of oxidation are intermediate between vanadium and copper, and produce splendid blacks.—*A. Guyard.*

ANIMAL ELECTRICAL CURRENTS.*

TWENTY-FIVE years ago Dr. Radcliffe was present at an experiment upon a rabbit, and was surprised to find that the muscular spasm, induced by subcutaneous injection of strychnia, continued four days after death, and that the muscles did not relax until after putrefaction had set in.

Later, the temporal artery was divided in an epileptic patient during a paroxysm, and the blood, although escaping in jets, was black; venous, not arterial.

Again, while studying with Matteucci the action of strychnia upon the electric ray, he observed that involuntary electric shocks accompanied the spasms caused by the poison, and was much impressed with the theory of this physiologist in regard to the influence of static charges on muscular movements.

To these three facts may be ascribed his researches and subsequent convictions, which led to the publication of "Philosophy of Vital Motion" (1851), "Dynamics of Nerve and Muscle" (1871), and the book before us. Although we cannot agree with Dr. Radcliffe in his philosophy of animal currents, and the laws of muscular contraction, we must thank him for his clearness of diction and fascinating style. There can be no doubt about his meaning; there is nothing pretentious in his claims or manner of making them.

Space will not permit us to review in detail all that is presented in support of his views on these important matters. Among the many subjects of physiological interest to which he applies his theory, those which draw our attention most forcibly are the following: 1. Animal electricity; 2. Action of so-called "direct" and "inverse" voltaic currents upon muscle and nerve.

Experimenting with the quadrant-electrometer, the presence of static charges, positive or negative, as the case may be, is readily detected in both muscle and nerve. The longitudinal surface has a positive, the transverse surface a negative charge.

These charges of free static electricity may, according to our author, not only govern muscular contraction and relaxation, account for the animal currents of Du Bois-Reymond, and the phenomenon, "Negative Variation," but also explain the polar action of electricity when it is applied to muscle and nerve.

The following considerations occur to us as conclusive in reply: We possess two instruments, chiefly used in physiology, to detect the two manifestations of electricity, called static and current. One is the galvanometer, the other the electrometer. The former is a test-instrument for the presence of a continuous current; the latter for the presence of a charge of free positive or negative electricity called static. Electricity which moves the mirror of the galvanometer is called a current, and that which moves the electrometer mirror is called static. These are the facts.

Now, with only one pole of a voltaic cell attached to the electrometer, we have a deflection of the mirror indicating a charge of static electricity; but the same pole, connected alone with one end of the coil of wire of the most delicate galvanometer, will have no effect upon the mirror, even when all the apparatus is insulated.

Charges from an electric machine move the galvanometer mirror, because the mass of surrounding wire is charged; but a single pole from a voltaic cell will not charge it. The difference between a current and a charge seems, therefore, sufficiently plain, although the reader will not find the distinction rightly made by Dr. Radcliffe. With the above facts in mind, it will appear that, to claim for static charges the production of the muscular current, for example, is just like claiming the same thing for a voltaic element. It follows that electrotonic movements of the needle (galvanometer) cannot be due (as proposed by Dr. Radcliffe) to a *portion* of the free electricity passing from one pole of the voltaic circuit along the nerve into the galvanometer circuit, because the whole of this free electricity from a single pole does not furnish a sufficient charge to deflect the mirror of this instrument. We shall continue, then, to hold to the expression, "voltaic current," in spite of the fact that a single pole can deflect an electrometer mirror; and also to the expression, "muscular current," in spite of the fact that a static charge can be detected here also by the same instrument. Again, in regard to the modifications in the condition of nerve and muscle induced by electricity, we fail to find in this work much help to a right understanding of Pflüger's laws. The fact is, that these laws are not modified by insulation of the frog-preparation. If the whole muscle be surrounded by water, and the liquid be connected by a wire to the earth, there is still no modification in these laws. Their explanation is not to be found, therefore, in the action of nerve-force on static charges in the muscle, for these static charges cannot exist in the muscle when the above connection with the earth is made. The truth is probably to be found somewhere between the two extremes of this controversy. The advocates of the current view, that is, that a current is always circulating, admit the presence of these static charges, but hold, and, as we think, correctly, that they are totally insufficient to account for facts, while the other side err in claiming too much for them. A similar division in opinion exists about the molecular hypothesis of Du Bois-Reymond. Quite a number of the leading physiologists of the day consider the muscular and animal currents as *chemical* phenomena, not *physical*. We confess our inability to see any difference between chemical and physical molecules, and, were all physiologists to agree in calling these phenomena "chemical," the polar-molecule hypothesis of Du Bois-Reymond would seem to us to lose nothing, and hardly to require a change of name.

If a muscle be a Leyden-jar, so is a voltaic cell.

If molecular motion in nerve and muscle be chemical, why is not the same motion in a magnet chemical? In one sense, both are chemical and physical. Notwithstanding the pleasure we have taken in reading "Vital Motion as a Mode of Physical Motion," we can see no reason for believing that the continuous violent shortening of a muscle in tetanus, *rigor mortis*, or during prolonged voluntary action, is due to the liberation of free electricity existing in its sheaths in a state of charge.—*New-York Medical Journal.*

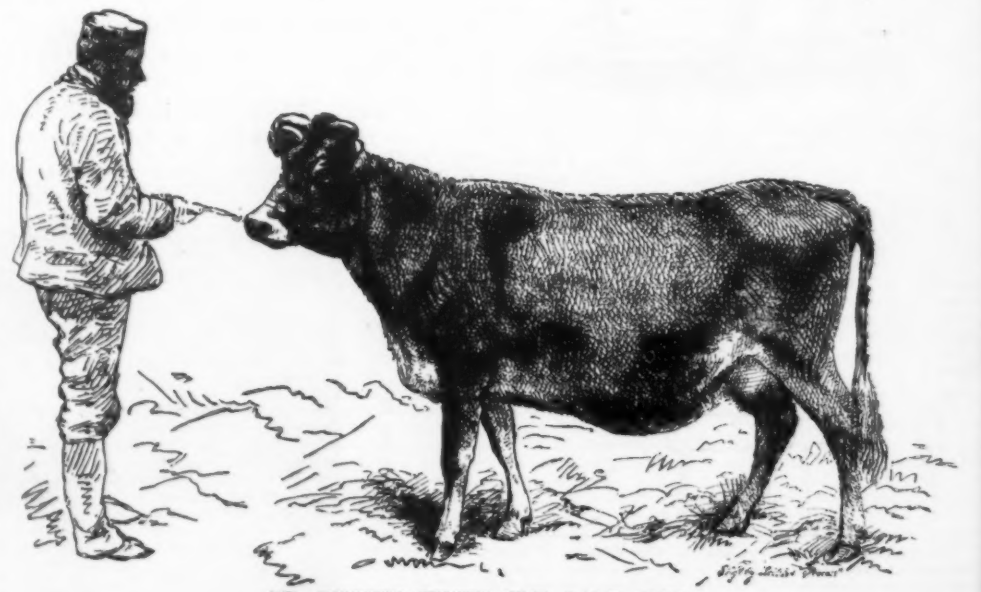
* "Vital Motion as a Mode of Physical Motion." By Charles Bland Radcliffe. London: Macmillan & Co., 1876. Pp. 252.

MR. GIBSON'S JERSEY BULL, DUCAL.

THE JERSEY BREED.

WE give illustrations of some excellent examples of Jersey animals, from the *Agricultural Gazette*. The bull, Ducal, is now about three years and four months old. He was bred by Mr. Walter Gilbey, and was by Banboy out of Duchess. Each of these has taken prizes at the largest English shows.

The cow, Lady Grey, was bred by Mr. Gaudin, Jersey. At one of the shows she took a prize, and was declared to possess twenty-eight points of merit—thirty the highest number possible to attain.



MR. GIBSON'S JERSEY COW, LADY GREY.

HOW LONG TO MILK A COW.

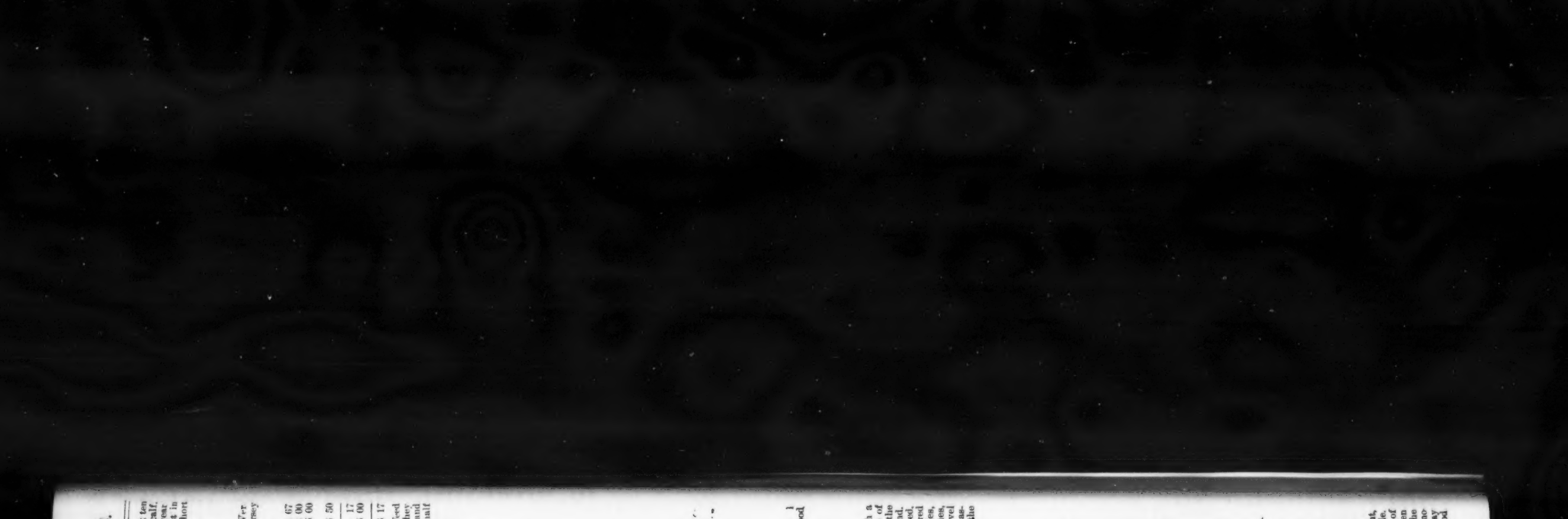
THERE seems to be a prevalent idea that it is not profitable to milk a cow more than eight or nine months, and most dairymen dry off their cows early and let them go dry three or four months. Is this the best practice? We think not. A cow is kept for milk. She should be bred for holding out her milk as long as she can, with due regard for health. It has been proved in the case of thousands of cows that have lived to good old age, that they can be bred to give milk ten months in the year, bear a good, healthy and strong calf, and be ready for as good a milking season the next year. We should seek such cows and discard those that persist in drying early, even if they do give a good mess for a short season.—*Maryland Farmer.*

HOW IT PAYS TO KEEP GOOD COWS.

I HEREWITH send you, writes a correspondent of the Vermont *Farmer*, a statement of the income of eight Jersey cows for the year ending January, 1876:

Twenty-five hundred and sixty-six lbs. eleven ounces of butter made and sold at forty cents per lb.	$1,026 67
Cream sold	2 00
Eight calves (6 heifers) raised	185 00
Ten pigs raised and fatted on sour milk and twenty-five bushels of meal	205 50
Total	$1,421 17
Less twenty-five bushels of meal	25 00
Total	1,396 17

My cows are full blooded Jerseys and three grades. I feed meal all the time they are giving milk. In the summer they have two quarts of corn-and-cob meal per day. Fall and winter, three quarts, one half corn-and-cob meal one half bran. We never have any soft butter in warm weather. I feed no roots of any kind, nothing but meal and all the good early cut hay they will eat.

A CHEAP MILK HOUSE.

I WILL give the description of a cheap milk house—such a house as any one can have if they will. Grandfather's is of hewn logs; the foundation of stone, one foot below the ground surface and six inches above, laid in lime and sand. The building is ten by twelve feet, one story high, chinked, and, after standing one or two years to settle, was plastered inside and out with lime and sand. The roof, of shingles, extends some four feet over the door; banked a few inches, all round to keep dry. Ground floor of nice, clean gravel got at the creek. A floor is laid overhead, of plank, to assist in equalizing the temperature. The receptacle for the crocks is a trough made of two-inch plank, water-tight, reaching full length of the building from outside to outside. The water enters from a lead trough four feet long, at left of door, and goes out the other end; after running some fifteen feet it enters a large trough, where the work horses and the cows always slake their thirst in summer. The water at no time is more than four inches deep. It is needless to say that in the warmest weather they have cool milk and good butter.—*Cor. Cin. Enquirer.*